



Déline Housing Report

Formline Architecture

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1.0 EXECUTIVE SUMMARY

Purpose

This Report is an assessment of housing in Déline within local environmental and cultural contexts. The findings in this report outline the current state of housing from the accomplishments and failures of previous efforts. This report is intended to inform the design of future housing models in the Déline Got'Ine community.

Methods

The information for this report was gathered through remote research, site visits to analyze homes, as well as consultation with occupants, local housing experts, community members and policy makers.

Recommendations and Conclusions

The greatest demand for housing in the community exists for single bedroom detached homes. Therefore Formline will proceed to design specifically for this need. Multi-unit dwellings are the most efficient and cost effective organization for one bedroom units but require several key design considerations to perform in existing conditions.

Spaces between multi-unit housing should be carefully considered since previous projects have proved incompatible with the local social patterns, leading to abandonment. To address this, entrances should be kept separate and the design should ensure privacy is maintained.

Spaces around homes should accommodate cooking tents, vehicles, sheds and other lifestyle equipment, while simultaneously providing high quality green space, which is lacking in the community. These units should also look to adaptations made by residents to existing building stock, to anticipate and purpose build spaces which relate to local cultural land based activities and climactic conditions. To address efficiency we have developed a design solution that is modular and can be adapted to stand alone, duplex, or quad-plex arrangements.

Based on our research we conclude the following building systems are most suitable.

Foundations

- Piles can be used if bedrock can be reached within budget. Residents prefer grade beams on pile jack platforms as it is easier for them to manually adjust. We considered the tubular space frame system however, feedback confirmed these systems are not easily adjustable.

Stories

- Two story homes are most efficient in volume to surface area ratio but must be equipped with ventilation and air return systems to push hot air down to the lower level. One story units are preferred by residents for accessibility.

Floors

- The preferred system is a raised heavily insulated floor system with a separate false floor of 2x4s or 2x6s to run electrical, plumbing or hydronic services without interfering with the continuous insulated framing.

Roofs

- We recommended a simple shed roof and variations, however community members are more attracted to a low pitched cabin style roof line.

Water and Sewer

- Units will have a 300 to 350 gallon water tank located in a mechanical room located on the main floor.
- Units will have a 250 to 350 gallon septic tank located between the raised floor and the ground. A heat traced line will be required between the sewage tank and the building and this should be located adjacent to water services.
- Water tanks must be filled 3 times a week. We recommend investigating a small compact grey water recovery system to filter sink and wash water to reuse for non-potable uses reducing the amount of water deliveries.

Heating and Ventilation

- Most of the units have an oil fired forced air furnace. To reduce energy loads we recommend a passive house building envelope, ERV units, high efficiency boiler and hydronic systems. Other alternatives may include a combination of wood burning stove to supplement this system.

Vestibule and Cold Storage

- A transitional zone in the form of an entry vestibule or porch with exterior and interior door to the living unit is required as a transitional zone between the heated space and the outside. This is to mitigate the icing that can occur on the exterior door and provide a warm place to dress for the harsh winter climate outside.
- We found that each living unit had a cold room added to the building for the storage and processing of fish and game harvested from the land. To address this need we propose enlarging the mechanical room to provide enough space for a chest freezer and seasonal clothing.

2.0 SITE CONTEXT



INTRODUCTION

Déline is in the Northwest Territories, 550kms North West of Yellowknife located at 65° N and 123° W. The community sits on the North West side of The Great Bear Lake's Keith Arm adjacent to the Great Bear River. The name Déline means where the waters meet.

2.1 LOCATION

- Déline is located in the Taiga Plains, Immediately below the Southern Arctic, seen in Figure 1.
- Figure 2 illustrates the subregion of the Taiga Plains where Déline is located containing undulating till plains, permafrost in low, wet areas and till deposits extending to the North East of the Great Bear Lake's Keith Arm.¹
- Déline is located in the Boreal Forest Region seen in Figure 1. The forest are mainly black and white spruce stunted at their northern edge of the Great Bear Lake, with Dwarf Birch, found extensively over recent burn areas.²
- The tree-line is located just North of the Great Bear Lake as seen in Figure 1.
- Figure 2 shows divisions of soil types within the Taiga Plains Low Subarctic Ecoregion. Déline is within the circle containing Plains, Lowlands, Hills Slopes and Uplands.

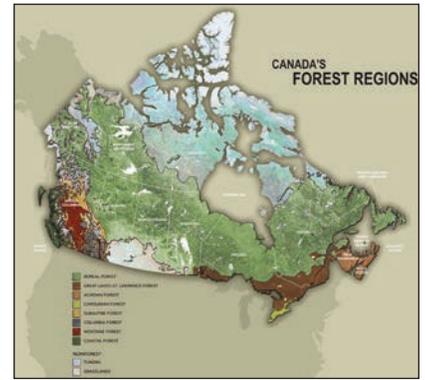


Figure 1 Forest Map of Canada

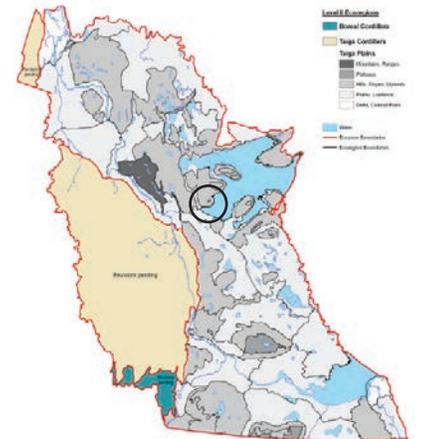


Figure 2 Level 2 Eco-regions



Figure 3 Taiga Plains LS Eco-region

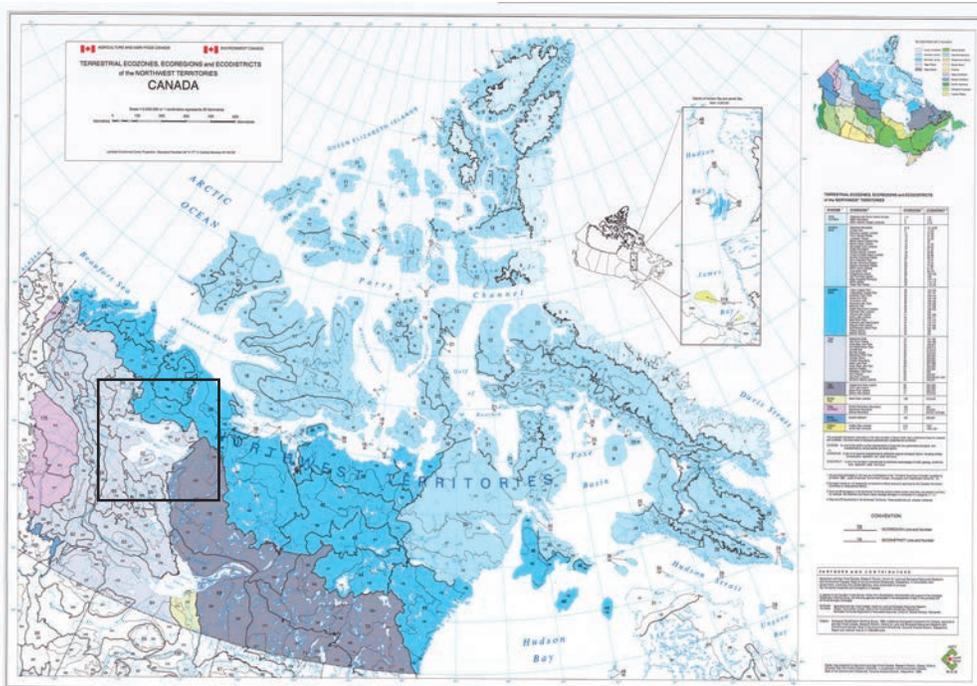


Figure 5 Terrestrial Eco-zone Map

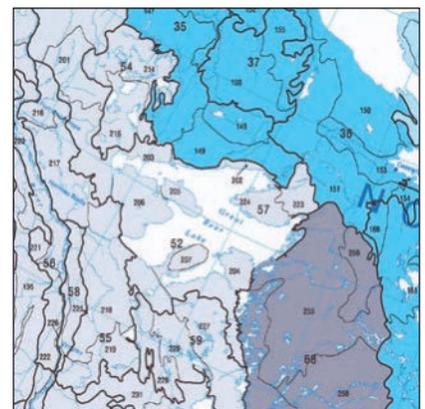


Figure 4 Terrestrial Eco-zone Map Blowup

2.2 CLIMATE

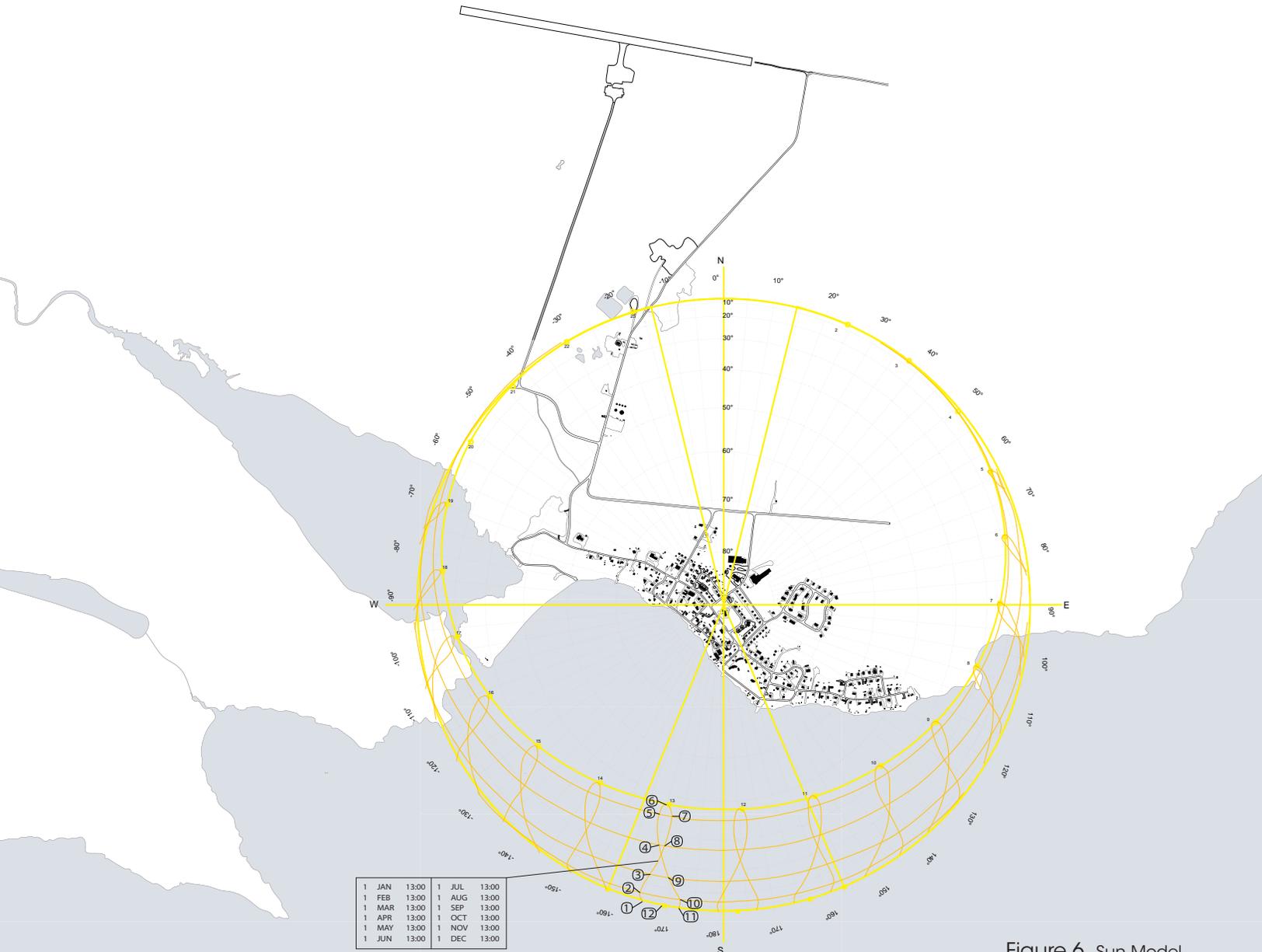


Figure 6 Sun Model
Inspired by Andrew
Marsh



Introduction

Déline is a subarctic community with a climate that is cold and dry with a high variation of sunlight over the year.

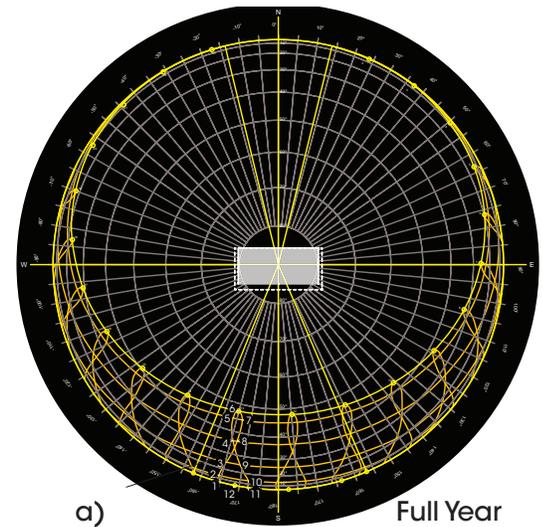
- Déline's temperature fluctuates drastically with January mean temperatures of between -25.5 to -29.0°C , and July mean of 11.0 to 16.5°C .³
- Precipitation is low with a mean of 230mm-350mm and a dry period between December and April.
- Sunlight is extremely variant over the year ranging from 21.5 hours of sunlight on June 21st to only 3.5 hours of daylight on December 21st.⁴
- Wind, according to community members comes steadily from the North but according to climate models comes equally from the ESE and WNW.

2.2.1 SUN

- The mean annual daily solar input ranges between 9.5 and 11 mJ/m²/day in the Taiga Plains Low Subarctic region.⁵

Figure 6 indicates

- The azimuth angle on Winter Solstice ranges from 157° to 203° creating very little solar exposure with low solar input values of 0.2 to 1.5 mJ/m²/day.⁶
- The azimuth angle at the height of the summer ranges from 14° to 346° causing higher solar radiation on the East and West facade with high values of 21.5 to 22.5 mJ/m²/day in June.⁷



Daylight hours - Déline, Canada

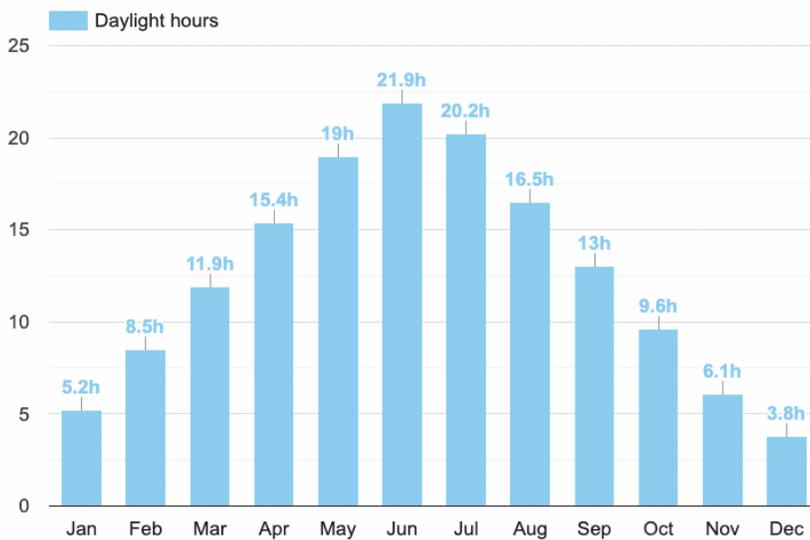


Figure 7 Seasonal Daylight Hours in Déline

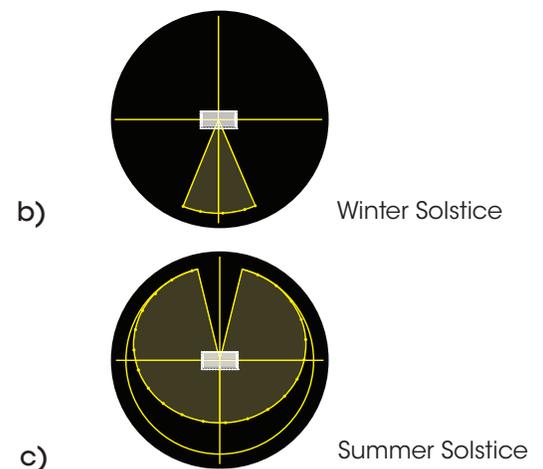


Figure 8 Sun Model Inspired by Andrew Marsh

2.2.2 WIND & PRECIPITATION

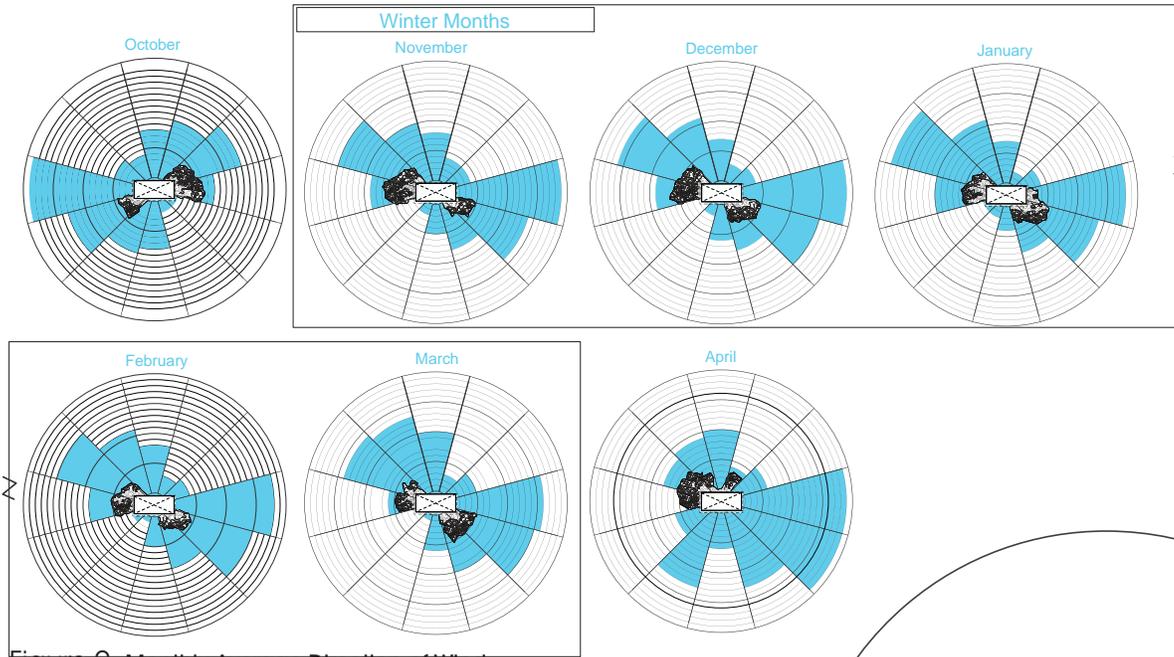


Figure 9 Monthly Average Direction of Wind

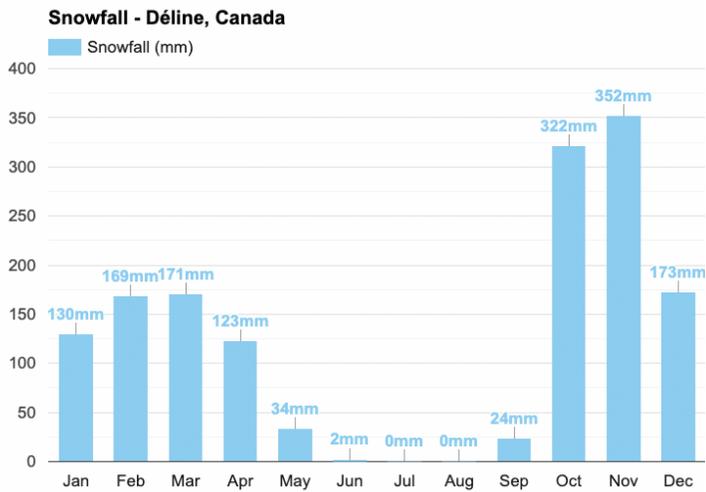


Figure 10 Monthly Average Snow Accumulation

Precipitation

- Average precipitation in Déline is estimated to be 210.7mm annually with heavy summer storms exceeding 50mm.
- Maximum snow-pack is reached in March.

Wind

- Primary wind directions are from ESE and WNW, as seen in Figure 9. The wind blows more heavily from the ENE at winter's end and stronger from WNW at winter's beginning. However, Traditional Ecological Knowledge indicates a primary wind from the North.
- Wind infiltration through windows, entrances and other openings should be taken into consideration. Wind infiltration through windows and vestibules is covered in section 5.2.6 and 5.2.3.

Snow Accumulation

- Figure 11 shows the approximate snow-drifting affect as the snow travels over the roof and drops on the lee side of the building not accounting for scouring affects. One possible result of scouring is wind clearing the snow from areas where it accumulates causing an even distribution of snow.
- Snow accumulation around entrances and the home was not cited as an issue by any community members and based on observation, snow distributes evenly across the ground, even around homes that have solid plywood skirts.

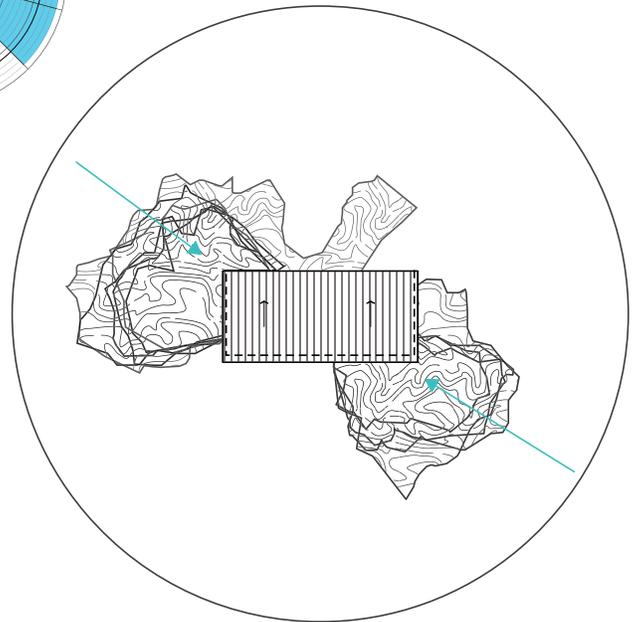
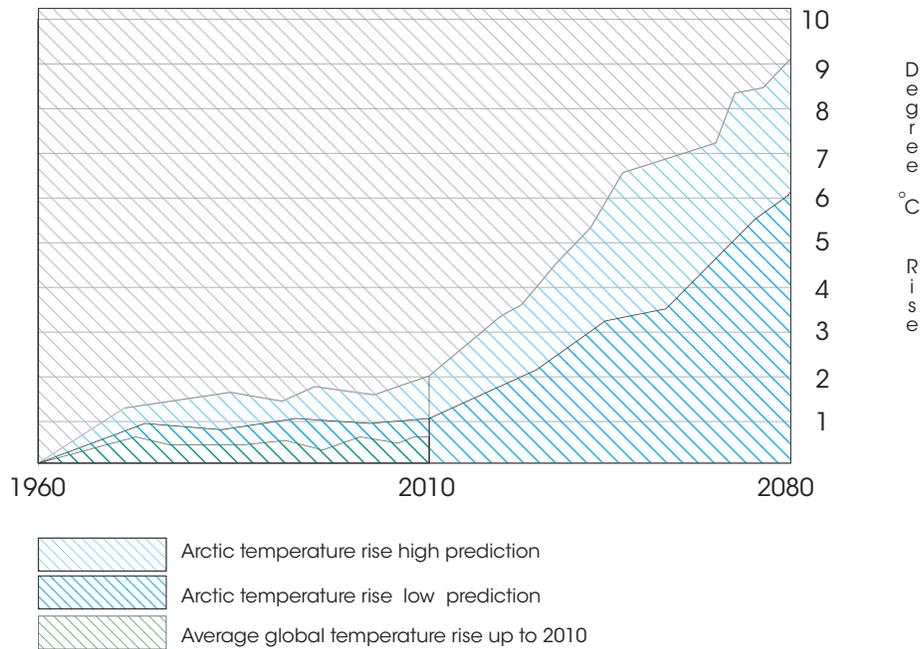


Figure 11 Snow Drift Patterns



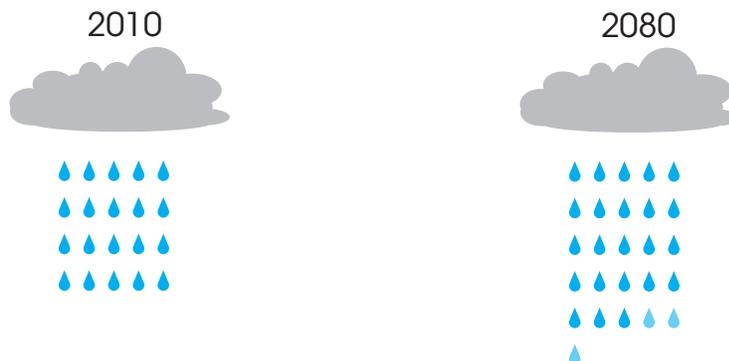
2.2.3 CLIMATE CHANGE

Average Global Temperature Rise vs. Western Arctic Temperature Rise Predictions



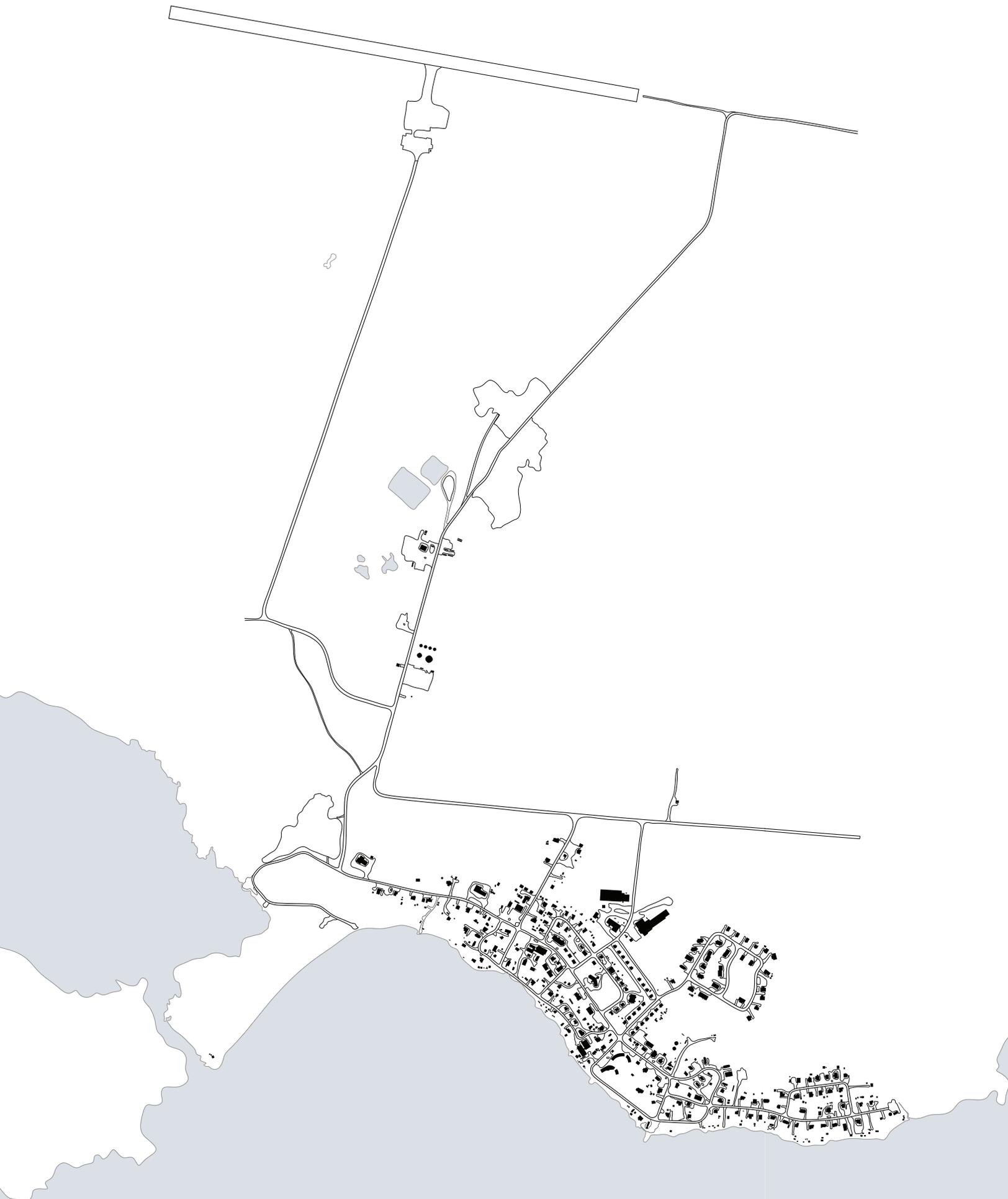
Temperatures have increased 1-2°C over from 1960 -2010 in the Western Arctic twice the global average. They are expected to rise another 4-7°C by 2080.

Precipitation Increase Predictions for Déline



Precipitation is expected to increase in the Western Arctic 15-30% by 2080. This would increase Déline's rainfall from 210mm to between 242mm and 273mm.

Stats Taken From: Lorien Nesbitt. Assessment of the Vulnerability of Déline's Water and Waste-water Systems to Climate Change Impacts Ecology North, March 31, 2010



2.3 DÉLINE VILLAGE

People

- Déline is a community of Sahtu Got'ine Dene people who first became a community in 1952 when the Canadian Government built a school.⁸
- Dene People are said by Anthropologists to commonly hold 4 basic traits being: individual industriousness and capability, generosity, personal autonomy, and emotional or personal restraint in social interactions.⁹
- Demographics in Déline from the 2016 Census
 - Population Total 534
 - Population 15 -64 380 71.0%
 - Population 0 -14 110 20.6%
 - Population 65+ 45 8.4%
- Median Income based on the 2015 Census: \$22,484.00
- Median Income from full time employment from the 2015 Census: \$81,004.00

Village

- Located on the Northern bank of the Keith arm of the Great Bear Lake, Déline's urban structure is spread across the shore and generally organized along a central road where the major institutions are located.
- Déline has: an Airport, Sewage Plant, School, Band Office, 7 Commercial Buildings, Traditional Knowledge Center, Government Offices, Lodge, Cabins, Water Pumping Station, Fire Hall, Co-op, Northern Store, Arena and 178 Residences.
- The community is organized in typical suburban form with all houses facing the road and informal parking occurring at the front of homes. Between homes there is little delineation between properties and yards are often full of vehicles, cooking tents and various other equipment.
- Gravel roads are maintained by a grader and become muddy during spring thaw requiring footwear be removed upon entry of buildings.
- The community has transitioned from growing parallel to the waters edge and now grows towards the airport perpendicular the waters edge. Expanding the community away from the water means homes and the urban grid relate less to the water and begin to form cul-de-sacs.



Figure 12 Déline Lot Map

2.4 INFRASTRUCTURE



Figure 13 Water Pumping Station

Introduction

Déline relies on the road network to maintain all infrastructure including hydro and electricity, requiring both local gravel and ice roads to maintain functioning. The municipal roads and ice roads are at risk of more frequent damage from washout, flooding, and other freeze thaw events increasing in severity and frequency due to climate change. The ice roads and local road networks depend upon stable base which could become compromised. Alternatives may need to be explored to prevent serious disruptions to infrastructure which is fully dependent on fossil fuels, particularly diesel, transported via truck on ice roads and stored locally in large holding tanks.



Figure 14 Diesel Electrical Generating Station

2.4.1 ROADS

Ice Roads

- Ice roads are now closing earlier by approximately one week and their thickness at the end of March has been reduced from 7 - 8' to 3 - 4' according to some community members.

Gravel Roads

- Figure 16 illustrates the low quality of gravel used for local roads. Aggregate sourced locally is impure and mixed with dirt causing it to heave with freeze thaw cycles due to improper drainage in poor quality aggregate. This may effect the delivery of water and removal of sewage among other vital operations.



Figure 15 Sewage Lagoon

2.4.2 WATER

- Water is sourced from Great Bear lake, treated with a UV filter and liquid chlorine before being transported to homes via truck.
- Chlorine levels are tested daily and samples from the wet well and water trucks are tested monthly.



Figure 16 Local Gravel

2.4.3 SEWER

- Sewage is removed from homes and taken to a sewage lagoon, seen in Figure 15 where it undergoes a two stage treatment before being decanted.
- Warming temperatures may destabilize berms surrounding the lagoons and threaten the community.

2.4.4 ELECTRICITY

- Electricity is provided by a diesel generating plant located in the center of town, see Figure 14, providing almost all of the electricity with the exception of one very small solar array.
- There is no backup to the power generation and there are discussions about moving the station away from the middle of the community to reduce noise, air pollution and improve sight-lines.
- The diesel for the generating station is held in two large holding tanks, seen in Figure 17.



Figure 17 Power Generation Diesel Holding Tanks



2.5 TRANSPORTATION LOGISTICS

Introduction

Déline's means of transportation are heavily reliant on the seasons. This is primarily trucking along ice roads with airplanes being a crucial means of transportation for goods and people. The ice road connects Déline to Tulita and Norman Wells, being the most important relationship socially and economically.

- Transportation by barge ended in 1978 due to a drop in water level and continues to be unfeasible. Some hovercraft testing was done but the project ended without plan for future progress.
- The window for transport along ice roads historically occurs from the end of January until the end of March. This window is shortening and is now ends in the middle of March, providing 2.5 months for construction material delivery. This renders a site in Déline for prefabrication beneficial.
- Nearly all products consumed by the community are imported from Yellowknife with the exception of game meat, a small number of logs used in construction, fire wood, and some berries.
- The average cost of materials and local building supplies for a standard home reportedly costs \$200,000.00. Building supplies and materials such as plywood, sold at the Co-op cost three times the price as stores in Yellowknife.



Figure 18 Fuel Truck Goes through the Ice¹⁰



Figure 19 Fuel Station Gas and Diesel Tanks



Figure 20 Ice Road and Highway Map



Figure 21 Typical Gravel Road in Déline

3.0 CULTURAL CONTEXT

INTRODUCTION

The community of Dèline enjoys a history with a rich heritage, spiritual identity, value system, and customs. The traditional language of Dèline Got'ine dialect of North Slavey is alive today, used in communicating the history of a people as well as land based narratives. The community maintains close ties to the land through these oral histories of places, geographical landmarks, animals, flora and land based activities. The community is reinvigorating this connection through developing strong ties to the canoe, and building an optimistic relationship to their future around these connections.

The community is proud to be managed through self-governance and gathers as a community around a shared connection to christianity and local prophet.

3.1 CULTURAL CUSTOMS AND TRADITIONS

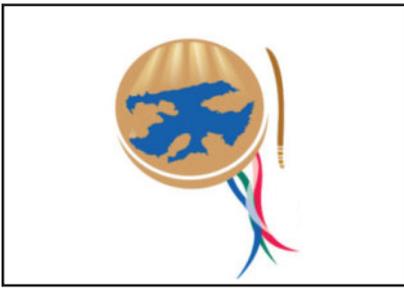


Figure 22 Délina Government Crest



Figure 23 Raven



Figure 24 Trout at Cookout



Figure 25 Tipi

Cultural Events

- Catholic prayer happens in May where community members gather in homes for prayer.
- Fire feeding allows people in Délina to participate in speaking with their Grandfathers.
- Cookouts at the Traditional Knowledge Center occur often when weather permits. Figure 24 illustrates the community gathering to eat game meat and bannock.
- Hand games are events to gather, gamble and meet new people and partners.
- Drum dances are an activity the community currently lacks adequate accommodation for. Dances require a circular space with a diameter of 60' according to Délina's chief.
- Church is heavily attended. The practice is a local version of Catholicism incorporating four prophets or visionaries from the community.
- Canoeing is a traditional land based activity built from birch bark or caribou skin before being replaced recently by motorboats. The Délina government is working to revive the practice, acquiring two large canoes for out trips.

Symbolism

Délina's crest, seen in Figure 22 incorporates four colour bands below the drum represent the four prophets who are central to Délina's religious identity. The colours correspond to the following spiritual meaning:

- White - Heaven
- Red - Blood of the Creator
- Green - Earth
- Blue - Water
- Yellow - Fire

Existing architectural symbols

- Tipi's in Délina are informed by the plains tipi as seen in Figure 25 rather than the wider and shorter Sahtu Go'tine tipi local to the area.
- The Délina government headquarters was built reflecting the shape of an eagle in plan with a tipi has the head holding the council chambers. The design and symbolism is largely well received by the Délina community.
- Homes and institutions excluding the government headquarters have *no* cultural symbolism in form or ornament and is not a priority for the community.

Land Relationships

Animals

- Raven is the most important bird to Délina as it is an animal tied to the creation story however, it's representation as a bad omen makes it an inappropriate symbol to represent in architecture.
- Caribou is a major food group and is commonly hunted. Traditionally their hides were used in the making of tent coverings, canoe hulls and clothing.
- Musk Ox which are taking over caribou territory are becoming more commonly hunted by the community but are not a traditional food source.
- Porcupine quills are dyed and used for bead work.
- Fish are the staple of the community's diet. Herring being the most common and trout the most popular.
- Sable, Marten and Mink are trapped for market sale of furs.



3.2 LAND USE

3.2.1 HUNTING AND FISHING

Hunting

- Caribou are an integral part of the traditional diet of the Déline community. The herds are hunted in areas to the north and south of the Great Bear Lake's Keith arm where the community is located, the Caribou have also been tracked to the East as seen in Figure 26 and West as seen in Figure 29, but this was not reported by the community to be where the community hunt.
- Caribou can also be found across the river at Grizzly Bear Mountain, highlighted in Figure 29.
- Caribou provide all essential nutrients with the exception of Vitamin D found in fish.¹¹
- Musk Ox have become more common in the region and are becoming a larger part of the diet since being banned in 1917.

Fishing

- Fish provide a large portion of the diet in Déline. Commonly fished species are Lake Trout and Herring, the former being preferred.
- A new program in Déline has been set up to encourage net fishing. One community member is net fishing and provides much of the community with fish.
- Climate change may increase the bio-accumulation of PCBs (polychlorinated biphenyls), DDT (dichlorodiphenyltrichloroethane), and heavy metals in local fish populations, causing adverse health effects within the community.¹²

3.2.2 LAND & RESOURCE GATHERING

Natural Resources

- Berries and medicinal plants are not central to land activities but berries are still collected and some community members are still well educated in medicinal flora.
- Foraged berries include: Cranberries, Knuckle-berries, Cloud-berries, Bear-berries (no longer collected) and Blackberries.
- Figure 24 illustrates the traditional use of spruce boughs as flooring in tipis, sometimes used as a covering when caribou hide was not available. Spruce poles are still used for structure in cooking tipis.
- Trees are harvested around the community and can be found between 10-12" according to the local chief.

Landscape

- Great Bear Lake provides the community with the bulk of their food and is the most important feature of their landscape informing the layout of the Déline community.
- The Bear River is the second most important landscape feature which determined the original siting of Déline.
- The Mackenzie Mountains are the third geographic element anchoring the community with a presence on the horizon often used for orientation.



Figure 31 Musk Ox in Cold Room



Figure 30 View Towards Lake

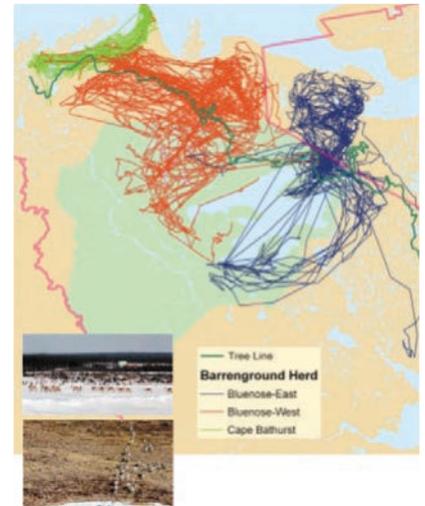


Figure 26 Caribou movement patterns around Great Bear Lake.¹³



Figure 27 Net Fishing Herring



Figure 28 View across Great Bear Lake

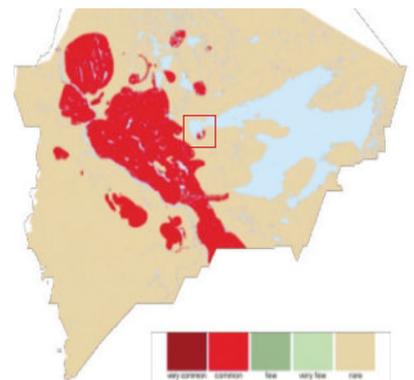


Figure 29 Caribou movement patterns around Great Bear Lake.¹⁴

3.3 VERNACULAR ARCHITECTURE



Figure 32 The Dog-rib Indian and his Home. Photo by Wheeler, D.E. 1914.

There are two main precolonial vernacular typologies in the Great Bear Lake region. The split stick house and the more common, caribou skin tipi.¹⁵ Since the colonial period canvas tents and the log cabin have become the typologies the Déline community identifies most with.

Split Stick House

The split stick house is an A-frame shelter made of leaning poles which form both the structure which is then chinked with moss to form a tight envelope. More permanent versions of this structure had post and beam systems, hexagonal or rectangular in plan, with thinner leaning poles around the exterior.¹⁶ The split stick house was a winter dwelling which housed two families, but was seen as an inferior housing type compared to the caribou skin tipi.¹⁷ The split stick house was not mentioned by the community as a part of their local tradition.

Caribou Skin Tipi:

The caribou skin tipi was a prized possession of communities living in precolonial Northwest Territories. The completion of a caribou skin tipi along with other prize possessions such as toboggans, birch bark canoes and willow bark nets were marked with ceremonies and songs.¹⁸ The tipi's skin slopes more gently than the plains tipi, ending at the top in a large opening, which does not require wind flaps due to its size.¹⁹ On the interior, floors were dressed in spruce boughs which were replaced regularly. To keep the boughs from falling into the fire a wooden pole was notched 7 times, bent and pegged around the fire to form a hexagonal perimeter. To prevent dogs from entering, toboggans were often placed at the door and to prevent the dogs from peeing on the tent, branches are piled around the tent's perimeter.

Post Tipi Vernacular:

Caribou skin tipis were replaced quickly upon the introduction of canvas in the 1920's followed by the subsequent replacement of canvas tents by log cabins.²⁰ Despite popularity, as recently as 1975 some people still preferred tents to cabins for their superior ventilation.²¹ Today the people of Déline gravitate towards the log cabin which the community identifies with over the traditional tipi and split stick A-frame.

Tipis in Déline are now used as cooking tents rather than shelters, have a steep pitch and wind flaps, resembling more closely the plains tipi. These are often clad in plywood at their base for durability.

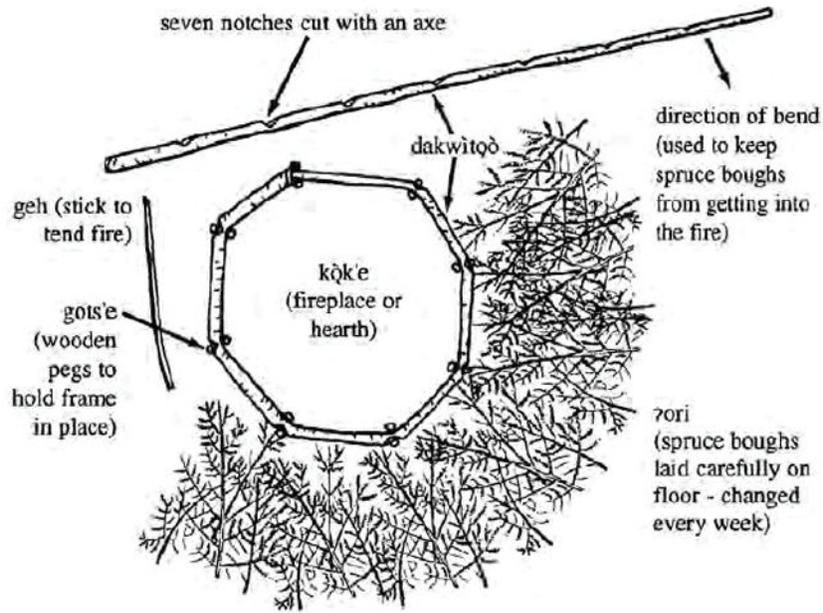


Figure 33 Illustration of Hexagonal Fire Ring and Spruce Branches

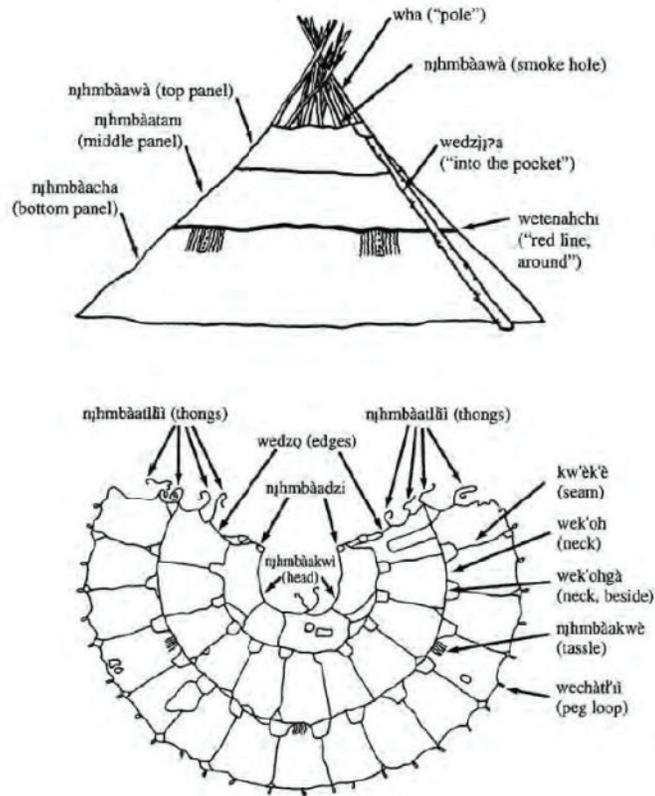


Figure 34 Illustration of Caribou hide sewing pattern

4.0 GOVERNANCE



INTRODUCTION

Déline Got'ine has formed self-governance since the signing of the Final Self Government Agreement in 2013 by Déline First Nation, Déline Land Corporation and the Government of the Northwest Territories.²² This decision was supported by the Déline First Nation and the beneficiaries of the Sahtu Land Claim.²³ The Déline Got'ine Government has now, successfully combined under one name, the Déline First Nation, Déline Land Corporation and Déline Charter Community, a goal set fourth by Déline's prophet Ehtseo Ayah.²⁴

4.1 DÉLINE GOT'INE SELF GOVERNMENT

The signing of the Final Self Government Agreement and the dissolution of preexisting governing bodies into the Déline Got'ine Government is a transition supported by the majority of Déline's citizens and has implications such as:

- Taxes paid by community members of Déline are returned to the Déline Got'ine government for use at their discretion.
- Housing budget has decreased from \$1,500,00.00 to \$750,000.00.00 until further funding can be acquired in future agreements with the Canadian Government (note taken from a conversation with the current chief) .

4.2 HOUSING GOVERNANCE & FUNDING

The bubble diagram right describes the funding path through governing bodies from the Federal Government to the Déline Got'ine Government. Leaders in the community state that each governing body the funding passes through reduces the amount of funding that local government receives. To remedy this, Déline is working towards a direct relationship with the Federal Government with respect to funding for housing. However, this may not be achieved for many years.

Funding:

- The Déline housing budget has reportedly dropped from \$1,500,000.00 to \$750,000.00 which occurred during the process of taking self government. Taking self government also means that Déline must negotiate for continued housing funding or a settlement fee from the Canadian Government.
- The 75% mortgage assistance program from the government is not accessible to those households who make over \$90,000.00 a year.
- The rental assistance program means an unemployed person pays \$70.00 in rent per month while an employed person pays \$1000- 1400 per month in rent.

Déline's Got'ine governments building stock includes:

- 119 rental homes with a maintenance staff of 3 people.
- 13 staff houses, 7 industrial buildings, 8 cabins, Fire Hall, School, Garage, Water Plant, Arena and Youth Center are managed and maintained by the Déline Got'ine Government.
- 40 Private homes are the responsibility of home owners for maintenance and upkeep.

The Homeownership Assistance Program (HAP) 1986, offered by the Government of the Northwest Territories was the most successful housing program in Déline according to many community members. Programs which have replaced HAP have not been as well received. HAP can be seen as an architectural microcosm of self governance, giving the occupant a sense of ownership.

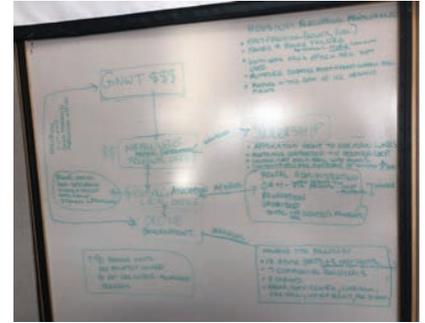
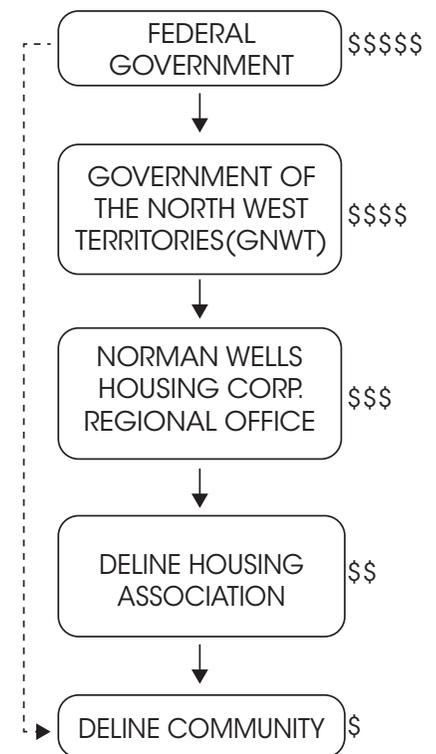


Figure 35 Housing Governance and Funding Diagram



5.0 HOUSING IN DÉLINE



INTRODUCTION

During our time in the Délene community we visited a variety of housing typologies including multi-unit residential, one and two story detached homes, ranging from one to four bedrooms. The most successful housing typologies based on community input are the HAP (Home-ownership Assistance Program) houses. The least appreciated housing types were the now abandoned multi-unit residential buildings followed by the quad-unit type. The multi-unit residential buildings are abandoned due to issues with adjacent doors causing privacy and acoustic issues.

Two funding models were in place during the Federal Governments control in Délene with varying degrees of reception from the community. These were "Housing Assistance Program (HAP) Houses" and their predecessor program "Access Housing". The HAP funding model gave participants the material to build the structure and envelope of the home, \$4000.00 to pay for help with additional labor a provided by the owner/ occupant and a paid electrician to wire the home. Interior finishes were to be funded by the occupant. Funding the government put towards the homes structure and envelope was lent to the occupant as a 5-year forgivable loan. This has proved to be a successful model for some and promoted a sense of ownership, avoiding the work order process of non occupant ownership which results in less homes falling into states of disrepair.

Access housing according to the community was a less appreciated funding model, requiring community members to take on a continual mortgage. Maintenance of homes was most successfully up-kept by those who maintained ownership. If they do not maintain ownership, work orders must be requested which proved to be an inadequate system. In the community there are examples of doorknobs that do not get changed for 3-4 months after work orders are submitted. A fix that would apparently require about \$30 in hardware to fix, according to one community member. Another account by Ray Tutcho, the old chief states that he has never seen anyone adjust screw jacks, which may be because people are not maintaining their homes or because the ground is not settling. People who own their own homes tend to do renovations on them, especially those who participated in the HAP who gained a sense of ownership through building.

Homes are often renovated and have additions which facilitate culturally important land-based activities such as cold rooms, for skinning and storing meat. This included a large door to bring game in from the outside is equipped with a double-wide freezer for large game. Note that Elk are between 1.5 and 2.1 meters long and would not easily fit through a standard residential door.

These renovations are also aesthetic interior modifications which often reflect a desire to feel at home, in a warm cabin like setting. Examples include the addition of vinyl flooring patterned to resemble wood, and this desire should be anticipated by designers to reflect the preference of occupants on an individual basis. Sheds are a common addition to homes for storing tools and parts. These are a part of almost every home and are small, usually around 8x12'. These sheds are often constructed from recycled shipping crates used for building materials shipped to the community.

Indoor gathering spaces are in limited supply, found only in the front lobby of the government buildings where coffee is provided and people gather casually. This roll was previously fulfilled by the Traditional Knowledge (TK) building and the housing office but it is now limited the government office. This may be a consideration when developing gathering spaces in homes. A place to hang out and sit down is needed which has big windows and a view to the lake says Bruce Kenny. An outdoor gathering space exists in and around the tipi behind the TK building where cookouts occur with meat from the land however an outdoor gathering space should be incorporated adjacent to individual homes.

5.1 HOUSING TYPES

2 BEDROOM DUPLEX

PROJECT DETAILS

TYPE:
DUPLEX

TOTAL AREA:
949 SQ. FT. X2

FOUNDATION:
MULTI-POINT

BEDROOMS:
2 BDRM X2

STORIES:
1 STORY

CRAWLSPACE:
NO

HEATING: OIL BURNING BOILER,
FORCED AIR

VENTILATION:
OIL BURNING HYDRONIC FORCED AIR



Figure 36 Duplex With Multi-point Foundation Front View

DESCRIPTION

This Housing type is called a "Duplex Multi-point Foundation Below The Tree-line" as seen in Figure 88. The drawings for this home were issued in 2003 by the Northwest Territories Housing Corporation. There are several different Duplex types. Figure 88 has a multi-point foundation and corresponds to the drawings on the next page. An alternative variation in the Appendix uses a screw-jack foundation rather than the multi-point foundation.

Foundation

- The duplex shown in the drawings and in Figure 88 has a multi-point foundation arranged in a 6'8" square pattern, elevated 3'3.25" off grade
- The feet of the foundation sit on pressure treated cross laminated pads to distribute the load
- Glulam grade beams sit on 2x6 shims inside a 3/16" plate steel saddle bolted with 1/2" bolts

Heating and Ventilation

- Heating is provided by an oil burning boiler providing hydronic heating to a forced air ducting system located in a suspended ceiling
- The boiler is located in the water storage room in the front of the home along side the water tank and hot water heater
- Ventilation is provided by a fresh air intake also located in the roof above the mechanical room

Envelope

- Wall construction is 2x6 studs, 6" batt insulation and semi rigid insulation with 2x2 strapping on the interior face of the studs
- Exterior cladding is a pre-finished hardboard. Interior finish is 5/8" fire rated gypsum board
- Windows are double glazed hollow core vinyl windows with 3/4" pine casings

Water and Sewer

- The potable water tank is located in the water storage room at the front adjacent the mechanical room at main floor level
- Two sewer tanks are located to the left and right of the building, one for each unit to avoid long travel distances for pipes

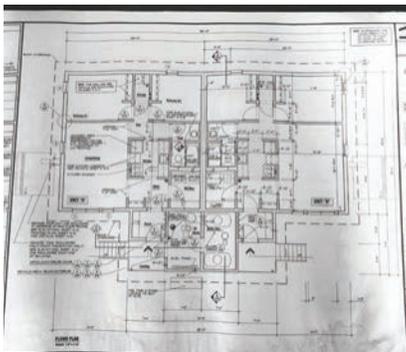


Figure 37 2 Bedroom Duplex Plan

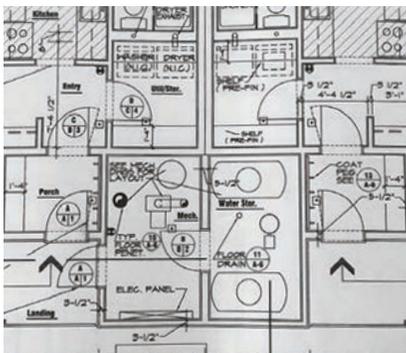


Figure 38 2 Bedroom Duplex Shared Mechanical and Water Room



4 BEDROOM HOUSE TYPE HAP G



Figure 39 View of House From Lake

DESCRIPTION

This housing type was owner built under HAP, a well received program by owners of these homes. These homes continue to be a sought after, remain well maintained and often adapted through renovations. The drawings for this home were dated between 1986 and 1987. The home is a one story unit characterized by an asymmetrical roof line, attic space, minimal eaves, two entrances and one bathroom.

Foundation

- Steel pile foundations with solid wood grade beams

Heating and Ventilation

- Oil burning forced air furnace, a wood stove and an oil burning Toyo stove provide heating
- Forced air system and operable windows provide ventilation

Envelope

- Exterior cladding is wood siding, planed to look like logs
- Windows are double-glazed wood frame (a popular choice in the community for their thermal performance)

Water and Sewer

- Potable water tank is located in the mechanical room next to the kitchen, labeled 10 in Figure 38
- Septic tank is located below the home, heated with an electric heat trace and enclosed by plywood skirting

PROJECT DETAILS

TYPE:
SINGLE DETACHED

TOTAL AREA:
1156 SQ. FT.

FOUNDATION:
STEEL PILES

BEDROOMS:
4 BDRM

STORIES:
1 STORY

CRAWLSPACE:
NO

HEATING:
OIL BURNING FORCED
AIR, TOYO STOVE &
WOOD BURNING STOVE

VENTILATION:
FORCED AIR

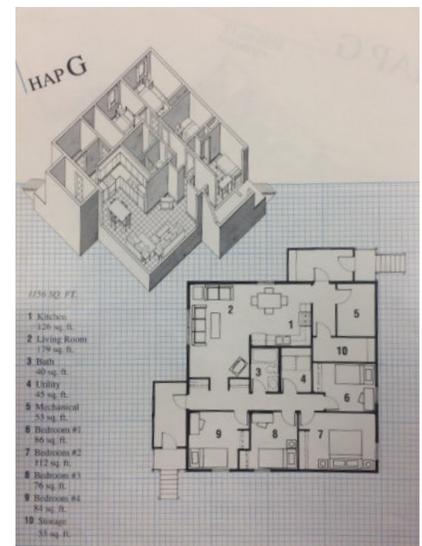


Figure 40 Hap G Booklet, Plan & Axonometric

2 BEDROOM DETACHED

PROJECT DETAILS

TYPE:
SINGLE DETACHED

TOTAL AREA:
UNKNOWN

FOUNDATION:
SCREW-JACKS

BEDROOMS:
2 BDRM

STORIES:
1 STORY

CRAWLSPACE:
YES

HEATING:
TOYO STOVE &
WOOD BURNING STOVE

VENTILATION:
MINIMAL



Figure 41 Front deck with bench and chest freezer

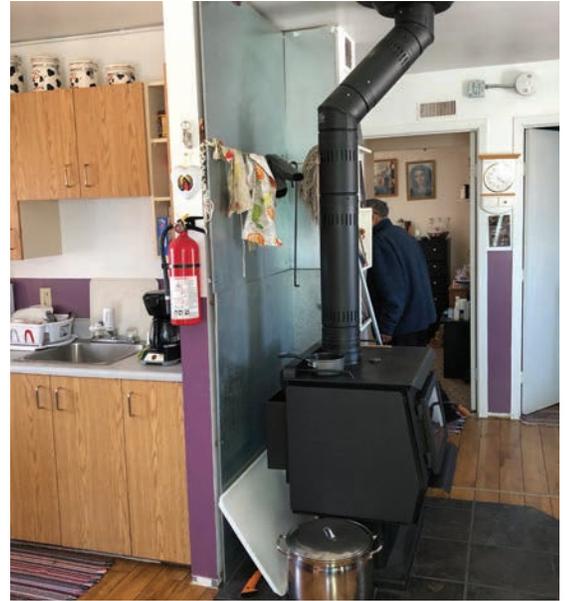


Figure 42 Wood burning stove and chest freezer

DESCRIPTION

This home has an open plan with the with a connected living-room and kitchen. The home has a crawlspace with water and sewer and no mechanical room on the main floor. The house has a low pitched roof with an insulated attic space and gypsum board drop ceilings. The bathroom in this house is lifted at the rear under the toilet and bathtub seen in Figure 98 in the Appendix, making it less accessible, especially given this is an elder's home. The floor has been topped with wood pattern vinyl planking in the main living areas.

Foundation

- Screw jack piles under grade beams enclosed by wood skirting to match cladding

Heating and Ventilation

- Wood stove and Toyo oil burning stove provide heat
- There is no ventilation system besides transoms made of metal floor vents located above each door (as shown in Figure 42) and operable windows.

Envelope

- Based on observation the envelope's exterior cladding is vertically installed wood siding and double glazed vinyl windows
- Interior finish is gypsum board

Water and Sewer

- Based on the raised floor in the bathroom and the presence of a crawlspace, likely both the potable water and the sewer are kept in the crawlspace beneath the bathroom and kitchen



3 BEDROOM HOUSE



Figure 43 3 Bedroom House Front View

DESCRIPTION

This housing type is a 1 story, 3 Bedroom home with a crawlspace. The home is an open plan with a connected living-room and kitchen. The roof is gabled with a consistent slope, insulated attic and a dropped gypsum board ceiling. The house has a mechanical room in the front hall which contains the hot water heater, and the forced air oil furnace. The floors have been redone with wood pattern vinyl atop the original tiles

Foundation

- Screw jack piles, where visible, appear to be resting directly on the ground but there is no sign of differential settlement. Drawings show screw jacks resting on wooden 3 ply pressure treated pads as seen in Figure 45
- Glu-lam floor beams connect directly to screw jack saddle

Heating and Ventilation

- Forced air oil burning furnace located in the mechanical room and a wood stove located in the living room
- Due to lack of maintenance the air ducts have become dusty, see Figure 103 in the appendix

Envelope

- Envelope is 2x6 studs, 6" batt insulation, 1 1/2" semi rigid insulation on the exterior with horizontally installed hard board panels for exterior cladding and an interior gypsum board finish.
- Windows are double glazed PVC with a removable storm window attached with plastic clips

Water and Sewer

- Potable water and sewer tanks are located in the crawl space, as seen in Figure 104 in the appendix, accessed from a hatch in the upstairs bedroom closet

PROJECT DETAILS

TYPE:
SINGLE DETACHED

TOTAL AREA:
1168 SQ. FT.

FOUNDATION:
SCREW-JACKS

BEDROOMS:
3 BDRM

STORIES:
1 STORY

CRAWLSPACE:
YES

HEATING:
OIL BURNING FURNACE &
WOOD BURNING STOVE

VENTILATION:
FORCED AIR

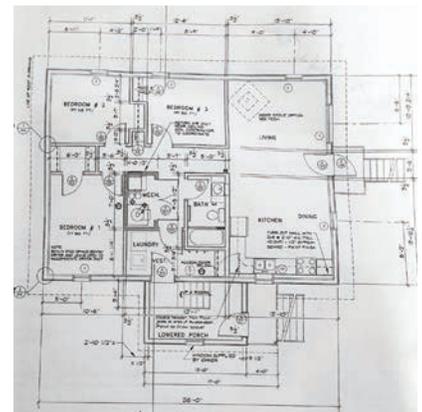


Figure 44 3 Bedroom Plan

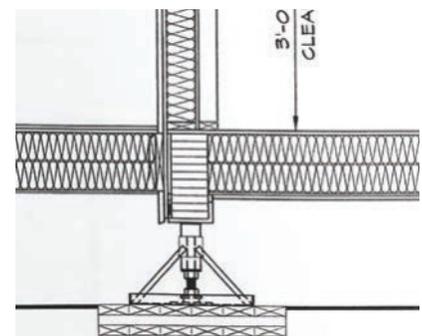
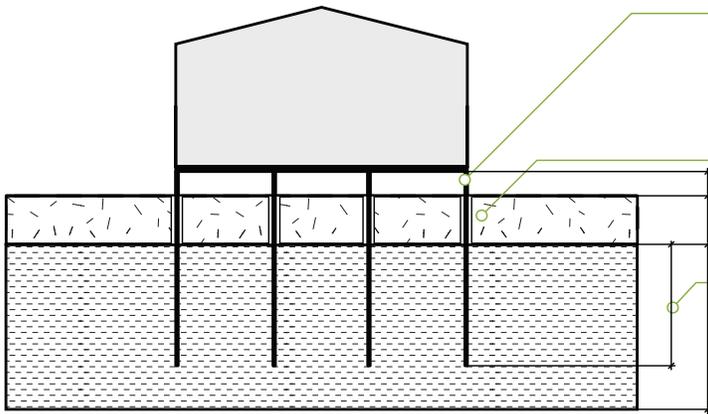


Figure 45 Screw Jack Foundation

5.2 BUILDING SYSTEMS

5.2.1 FOUNDATIONS

Adfreeze Pile Foundation



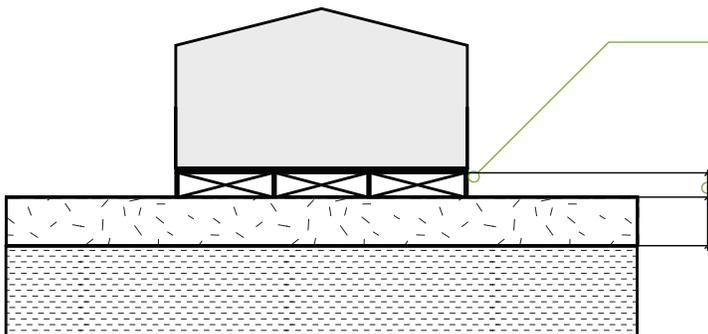
Adfreeze piles are the most common northern foundation but also the most susceptible to Climate Change as they rely solely upon adfreeze bonding to the permafrost layer.

Piles are coated in grease to prevent adfreeze bonding in the active layer which causes heaving.

Piles should be a minimum of 5m below the bottommost layer of permafrost to ensure against frost heaving.

Note: Foundations should be anchored against uplift due to wind and frost heaving.

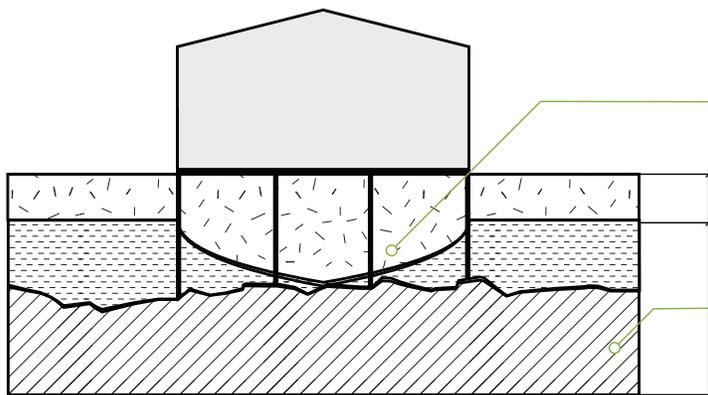
Triodetic Foundation



Triodetic Frames are custom designed for each home and due to their triangulation will likely be capable of resisting torsional wind-loads.

Foundation should be a minimum of 1m off the ground to ensure space for heat radiation from the floor to be dispersed by outside air adequately so that there is no heat transferred into the earth.

Bedrock Foundation

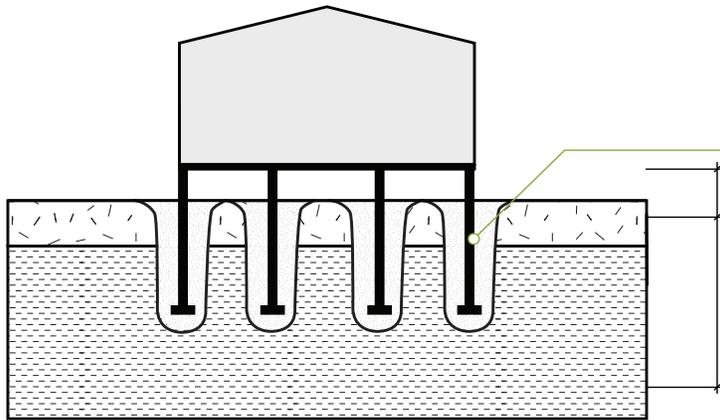


If a building is to be sited directly on the ground it will create a thaw bulb underneath the foundation which must be maintained to keep the ground beneath the building from heaving, and damaging the foundation.

The building can be sited directly on top of the soil if a solid footing material such as bedrock can be located within depth that can be reached within the project budget.

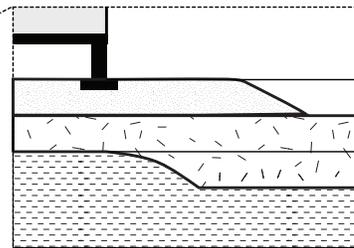
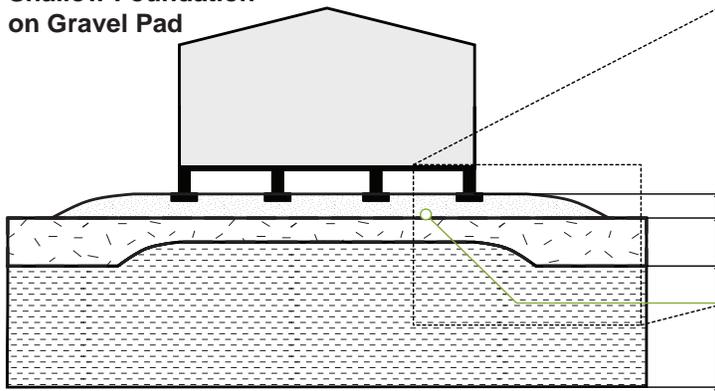


Shallow Foundation



Shallow Foundations have a tendency to heave and therefore must be accommodated in their structure.

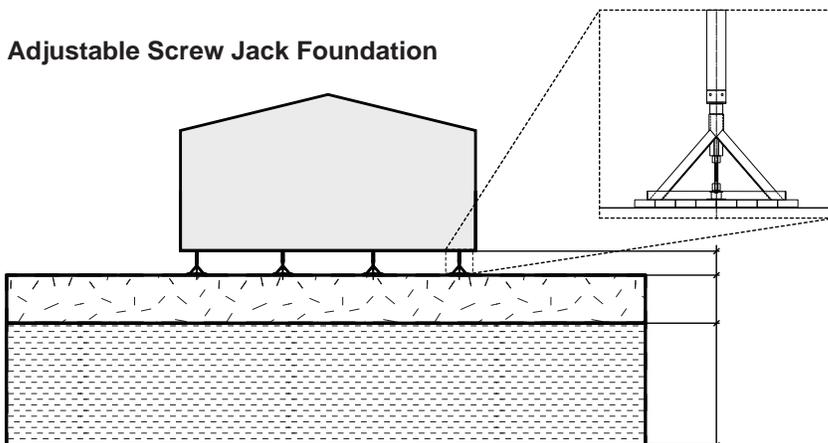
Shallow Foundation on Gravel Pad



Active Layer @ Gravel Pad
Original Active Layer

A shallow foundation requires solid stabilization to prevent shift and heaving. By adding a thaw stable soil, such as clean dry gravel, the Active layer becomes more stable since the thaw stable granular does not move as much as ice rich soil allowing for a shallower foundation.

Adjustable Screw Jack Foundation



An adjustable Jack Screw Allows for adjustment of the foundation to balance the heaving and settling of the soil over the year. The challenge is that it requires care to maintain functionality.

Legend

	Active Layer		Bedrock
	Permafrost		Gravel Fill (clean)

FOUNDATIONS IN DÉLINE

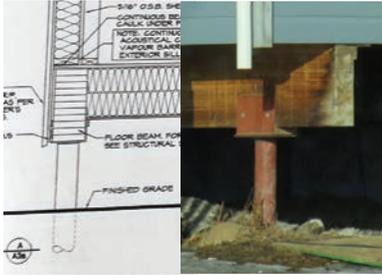


Figure 46 Floor Beam (left) vs Grade Beam (right) saddled to Steel Pile



Figure 47 Overextended Crib Foundation

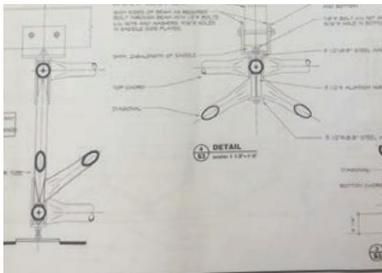


Figure 48 Multi-point Foundation

Piles

- Steel piles, according to testimonies by community members, are successful, with very few settlement and frost heaving issues
- Piles freeze directly into the ground or reach bedrock which provides a very secure base, there may be concerns with climate change as to how pile foundations will be effected
- Steel piles carry Glulam floor beams but more commonly carry Glulam grade beams as they create less thermal bridging and keep the home farther off the ground

Screw Jack

- Screw jack foundations should be constructed on a gravel pad to mediate the frost heaving effect of wet soils but note that gravel is not of high quality in Déline
- There is some debate among community members as to home owners maintaining their screw jack foundations

Wooden Crib

- Wooden crib foundations are a common and very inexpensive foundation type, they can be adjusted
- In some cases where intensive settling occurs, crib foundations can be stretched past their designed limit as seen in Figure 47

Multi-point

- Multi-point foundations have become more common in newer housing and institutional projects
- Multi-point foundations often sit on gravel pad foundations but due to the quality of the gravel and contractors not waiting for settlement before construction differential settling can occur as it has in for the traditional knowledge center
- Multi-point foundations have the most inherent strength of all the foundations and

RECOMMENDATIONS

Pile Foundations

- Foundation systems for arctic residential constructions should be lifted off the ground a minimum of 1 meter to prevent thawing of any permafrost that may lie below.²⁵ The best foundation would be a pile foundation with grade beams secured to bedrock or a stable layer of soil. The home should remain raised to keep the ground below frozen.
- It is important that climate change be accounted for, in the selection a foundation systems. Adfreeze piles depend on permafrost to remain stable therefore the increased depth of the active layer likely to result from projected climate trends will make these piles more prone to heaving.²⁶ There are additional systems such as thermosyphons which pull heat out of the ground, which can maintain the permafrost as temperatures warm but this is infeasible in single bedroom detached models.²⁷
- Typical piles can also be pulled out of the ground if the surface bonding and lifting force from the active layer is more than the holding strength of the deeper section of the pile.²⁸

Triodetic Foundations

- Settlement which occurs unevenly can be avoided by distributing the load over a large area using triodetic foundation. Triodetic foundations also remove the need for heavy equipment, extensive leveling and in most cases do not require timber pads under the feet.²⁹
- Triodetic Foundations can also be buried to bring the ground level closer to the floor level to increase accessibility and a connection to the site.³⁰

In conclusion if a pile foundation system cannot be founded on bedrock the preferred alternative is a Triodetic Foundation, followed by screw-jacks.

5.2.2 BUILDING STRUCTURE

Wall Types

- Typical Stick Frame Construction
 - Most common construction type, newer homes using 2 x 6, 24" o.c studs and some older homes using 2 x 4 studs with unknown stud spacing.
- Log Construction
 - 10 -12" logs are the alternative structural system to stick frame construction.

Roof Types

- 2 x 12 Rafter 24" o.c., Cathedral Ceiling, OR
- 2 x 4 Truss Roof 24" o.c. Insulated Attic

Floor Types

- 2 x 6 16" o.c. False Framed Floor on 2 x 10 16" o.c. Structural Floor with Grade Beams
- Double 2 x 12 Joist Floor 24" o.c. with Grade Beams
- 2 x 10 Joists 24" o.c. Main Floor and 2 x 12 Joists 24" o.c. Crawlspace Floor with Integrated Floor Beams

Recommendations

- Heaving foundations and the resulting effects are the only major structural issues, and are addressed previously in section 5.2.1. Foundations Findings. Documentation relating to the most successful systems for Roofs, Walls and Floors will be discussed in the 5.2.3 Building Envelope. Community input concluded the most sought after structural system is the log home, likely due to its relationship to an identification with a perceived local vernacular typology and the appeal of a wooden interior and exterior. Log homes are desirable, however to achieve a high performance envelope tongue and groove log siding combined with a high R-value wall is a necessary compromise to provide both functional and aesthetic performances.



Figure 49 Solid Log Wall Construction

5.2.3 BUILDING ENVELOPE - WALLS

Overhangs should be eliminated to prevent ice damming

Air barrier of roof should over-lap the air barrier in the wall but not adhere together and should be fully supported on two sides

A cathedral ceiling is preferred to a typical insulated attic for air circulation and to prevent snow from entering a ventilated attic space

Vapour barrier should act as a secondary protection against leaking from the exterior and therefore have a water tight lap seal

Drywall can act as an air barrier but performs poorly in shifting conditions which may occur due to heaving foundation as well drywall is easily damaged by occupants

Vapour barrier should eventually drain to the exterior

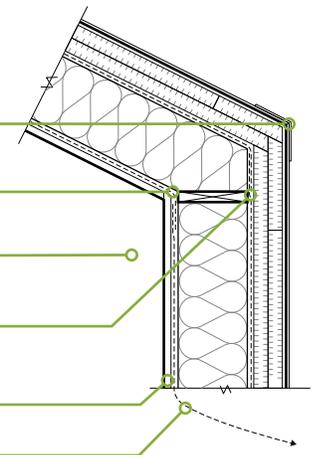
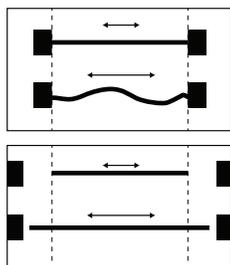


Figure 52 Diagram of Wall Section Principles



Oil canning of metal in fluctuating temperatures can occur with restrained edges as shown in the upper image of Figure 50. The lower image shows metal with an expansion joint.

Figure 50 Oil Canning

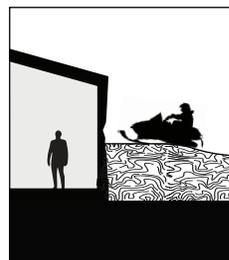
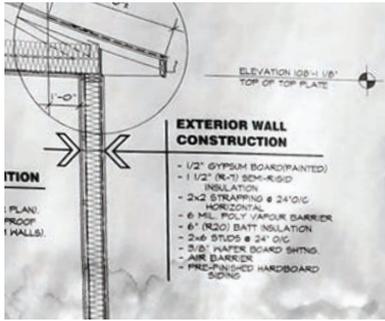


Figure 51 Wall Damage Diagram

Snow accumulating against a building gives the snowmobile potential to damage the building. Exterior cladding materials chosen should account for this potential and be replaceable.



WALLS IN DÉLINE

Typical Stick Frame Wall Construction

- Typical 2 x 6 walls are approximately 8 1/2" thick, insulation value of R-27 (not including windows or thermal bridging through studs)
- The exterior cladding is often either painted or stained cedar or pine, or concrete hard board siding, installed vertically or horizontally.
- Strapping and air gaps are not shown in drawings.

Log Construction

- Thickness approximately 10" , provides an approximate R 10.7.
- Sought after house type, described by some community members to be warm.

Figure 53 Typical 2x6 Wall Section

RECOMMENDATIONS

Wall Section

- The building should be insulated as a continuous line along the exterior causing the wall and roof to begin to take on similar properties. Figure 52 illustrates the wall as it continues up the roof to form a cathedral ceiling which giving the entire envelope a similar sectional composition.
- Community input concludes that the log home is preferential system but due its poor thermal performance is not optimal for an arctic community. The typical stud wall with continuous outboard insulation is an effective system but could be improved to provide a higher insulation value.

Finishes

- Interior finish can be wood, drywall or a combination. Drywall has the benefit of being an air barrier however it can be damaged negate this function and is difficult to repair in Déline. Interior wood finishes of either plywood or boards are the preferred material for durability and likeness to the log cabin which many community members prefer.
- Exterior cladding will not likely have to withstand damage caused by vehicles as seen in Figure 51, but should be durable and capable of expansion and contraction. Hardboard concrete siding and painted wood both perform well in Déline.

5.2.3 BUILDING ENVELOPE - WINDOWS

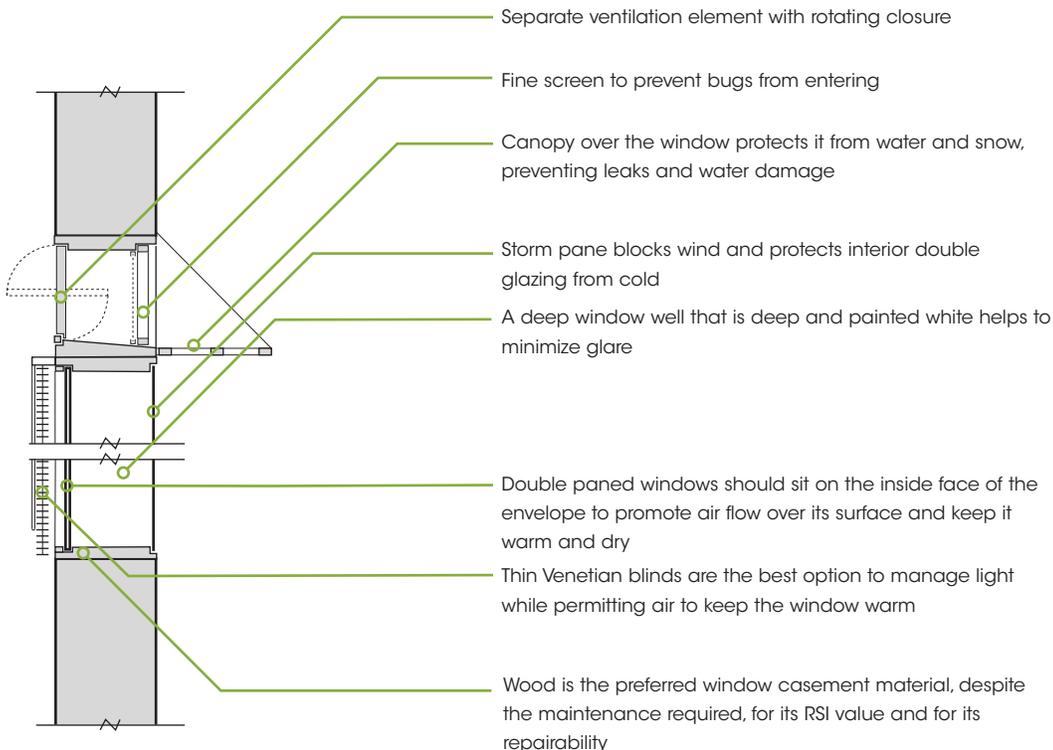


Figure 54 Window Ventilation Section

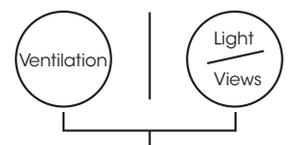


Figure 55 Ventilation and Windows Should Operate Separately frame

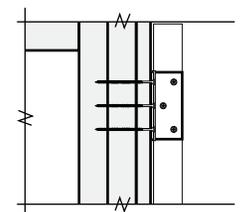


Figure 56 Screw Depth in door

5.2.3 BUILDING ENVELOPE - ROOF

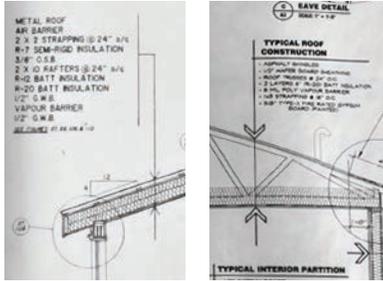


Figure 60 Cathedral Ceiling Construction (left) Insulated Attic Construction(right)

ROOFS IN DÉLINE

Cathedral Ceiling

- Approximate thickness is 15" with an insulation value of R - 40 as seen in Figure 60.
- Maintains continuous insulated line along the entire perimeter of the home .
- Higher ceilings may cause heat to rise above the level of the occupants.

Insulated Attic

- Variable thickness, insulation value R - 40.
- Blowing snow can enter through soffits and cause moisture damage however, there were no accounts of this issue in Déline.

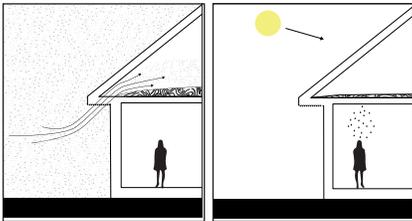


Figure 61 Fine Snow & Roof Ventilation Foundation

RECOMMENDATIONS

Roof Envelope and Structure

- The best roof system would be a cathedral ceiling which creates an optimal composition of a continuous line of insulation in the envelope with minimal breaks.
- Figure 61 shows a ventilated soffit and attic space where fine particles of snow blow through the ventilated soffit and collect in the attic until the snow melts and causes the ceiling to precipitate.

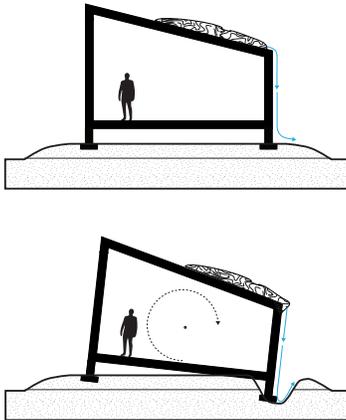


Figure 62 Drainage Eroding

Roof Type (Shed Roof)

- Shed Roofs are the best roofs for arctic communities for their simplicity, ability to shed precipitation and control facade size to optimize solar gain.
- Shed roofs should slope up towards the South for maximum solar exposure, with its highest ridge running approximately East-West.³⁷
- Figure 62 illustrates how snow deposited on the leeward side of the building melts and drains into the ground resulting in soil erosion and uneven settling of the building. This process can also result in more frost heaving from additional moisture content in soils.³⁸ Solutions to this may include weeping tile, paving or grading the earth at drainage points.
- Roofs in the Arctic should have little to no overhang and require a durable exterior cladding to protect against weathering.³⁹

Roof Penetrations and Ventilation

- Roof penetrations should be kept to a minimum as they can cause leaks.
- Some occupants of homes in the Arctic cut ventilation holes in their roofs resembling the ventilation ports found in igloos and caribou skin tipis which tends to help homes which suffer from ventilation issues.⁴⁰
- Skylights are problematic in the Arctic. They tend to release heat through the roof which melts snow causing ice to form.⁴¹ Due to the low sun angle skylights also admit little sun.⁴² If a skylight must be installed for any reason it should be oriented with its corners pointing parallel to the slope of the building or else be circular in shape.⁴³ Skylights should also have an evaporating pan on the interior downslope side to collect condensing water on the inside of the building.⁴⁴

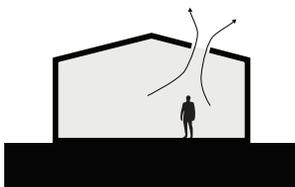


Figure 63 Adapted Ventilation

Diagrams informed by Harold Strub



5.2.3 BUILDING ENVELOPE - FLOOR

FLOORS IN DÉLINE

False Framed Floor on Structural Floor

- Overall thickness of 17 3/4" with an insulation value of R - 32 (R-20+R-12).
- False framed floor contains plumbing and services freeing the structural floor from penetrations and interruptions of it's R -20 insulation.
- Perpendicular arrangement of two floor systems reduce thermal bridging with joists only meeting at perpendicular intersections, see Figure 64 (right).

Single Insulated Floor

- Overall thickness of 13 3/4" with an insulation value of R - 40.
- The doubled joists are thermal bridges connecting the interior directly to the exterior along their length, see Figure 64 (left).

Main Level Floor Above Crawspace Floor

- Thickness of crawspace floor is 12 5/16" with an insulation value of R - 40, thickness of main floor is 10 1/2" with no insulation.
- The crawspace floor has thermal breaks along the length of each joist and at each floor beam.
- Occupants in these homes expressed issues with cold floors.

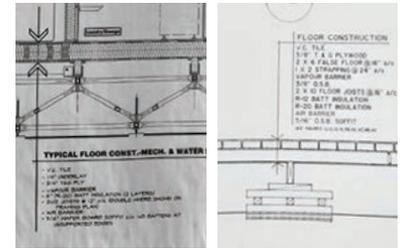


Figure 64 Single Insulated Floor (left) False Framed on Structural Floor (right)

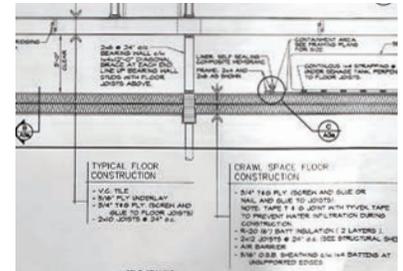


Figure 65 Main Level Floor Above Crawspace Floor

RECOMMENDATIONS

- Crawlspaces cause floors to become cold and occupy space which must be heated. If added to the design they should be as small as possible.⁴⁵
- A false framed floor over a structural floor is a system that performs well providing one floor for structure and insulation and another for plumbing and services, causing these floors to feel warmer to occupants.
- A height differential should be maintained between the vestibule and main floor of the home, with the vestibule resting at least two steps below, in order to trap cold air.

SEPTIC TANKS IN DÉLINE

- Septic tanks hold 250 gallons. They are emptied 3 times a week by a sewage tank and their location should be located adjacent to all sources from the building, and is contingent on the presence of a crawlspace
- Sewage vent stacks have some issues with freezing pushing septic smell into homes

No crawlspace

- Septic tank located outside the home requires either an electric or hydronic heat trace to prevent freezing
- Locating the septic underneath the floor in a trench is most common and is beneficial as it keeps sewage outside and does not require the home to have a crawlspace, challenges occur when frost heaving pushes the tank up, potentially into the underside of the floor which can be avoided by adding adequate space
- Septic tanks beside the home avoid issues of them running into the underside of the floor and allow for easier pumping and maintenance access but create a potential for pipes to freeze due to a longer travel distances
- Septic tanks in a cage attached to the underside of the floor, avoid issues of pipes freezing and running into the underside of the floor but will add construction costs

Crawlspace

- Crawlspaces hold both water and septic tanks in a heated interior space which sits beneath the entire floor area creating storage space but increasing cost and cooling the floors
- There are concerns among some community with the safety of having sewage in the crawlspace of the home

Water

- Water is kept inside the home either in the mechanical room or in a designated water room in a 250 gallon tank
- Water tanks are filled three times a week by a water truck via outlet. Some outlets have a red light to inform the tank is near full, if a light is not present the tank is filled until water comes out the overflow valve flooding the area around the overflow outlet



Figure 66 Septic or Water Tank in Crawlspace

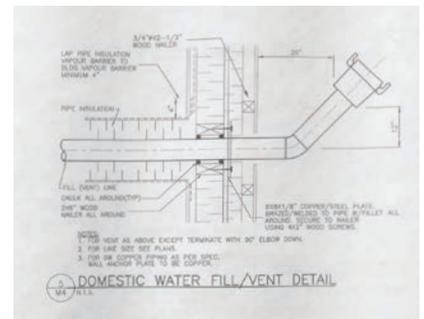


Figure 67 Water Tank Outlet



Figure 68 Sewage Tank Under House

RECOMMENDATIONS

Septic

- Septic tanks should be heat traced and located outside the home, as close to the bathroom and other outtakes as possible. If possible, septic tanks should be secured to the underside of the floor in a metal cage or built into a triodetic frame to prevent movement by frost heaving.

Water

- Water Tanks should be located inside the home in the mechanical room on the main floor.
- Water tanks should be outfitted with a water level sensor that indicates to water tank re-fillers when the tank is full to prevent overflows and floods around the water tank fill vent.



5.2.5 HEATING AND VENTILATION



Figure 69 Wood Stove (left) Toyo Oil Burning Stove

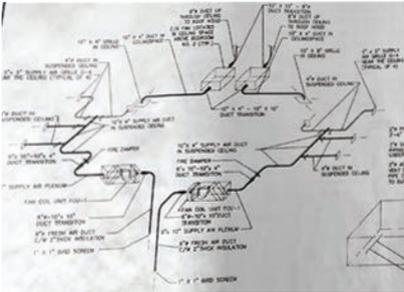


Figure 70 Hydronic Furnace Drawing (right)

HEATING IN DÉLINE

- Oil and wood are the only fuel sources used to heat homes in Deline, most homes using a combination of the two.
- Furnace boilers tend to fail and hydronic furnaces are more popular according to community member testimony.
- Oil burning hydronic forced air and oil burning forced air furnaces are programmed to hold the home at a steady temperature base with a secondary system heating the home to the desired temperature. A programmed furnace ensures the home remains adequately heated ensuring pipes do not freeze, even when the home is unoccupied.
- Toyo Stove are added by many owners since furnaces or wood stoves are not adequate, especially in Elders' homes.
- Wood stove are not air tight and do not have air circulation systems that moves warm air around the home. They provide an economical way of heating the home as they burn wood which can be collected at not cost.

RECOMMENDATIONS

- Oil burning hydronic furnace and forced air paired with a wood stove is an effective system but alternatives to oil and an airtight high efficiency wood burning stove should be explored.



Figure 71 Furnace Vent

VENTILATION IN DÉLINE

- Ventilation is in most cases provided by a furnace and sometimes relies completely upon windows and transoms.
- Kitchen fans are successfully used and maintained for ventilating cooking activities according to community member testimony.
- Two story homes do not vent hot air to the lower floor causing overheating on the upper floor and cool temperature on the lower.
- Ducting for forced air furnaces are not regularly cleaned and can become very dirty, see Figure 71.
- HRVs (Heat Recovery Ventilator) are often unplugged and left unused.

RECOMMENDATIONS

- Two story homes must be ventilated to pull heat from the upstairs and move it to the main floor.
- Ducting is not cleaned and HRVs are often unplugged for complaints of noise and energy loads requiring alternatives to mechanical ventilation such as portholes or ventilation ports under windows seen in Figure 58 to be explored.

5.2.6 VESTIBULE

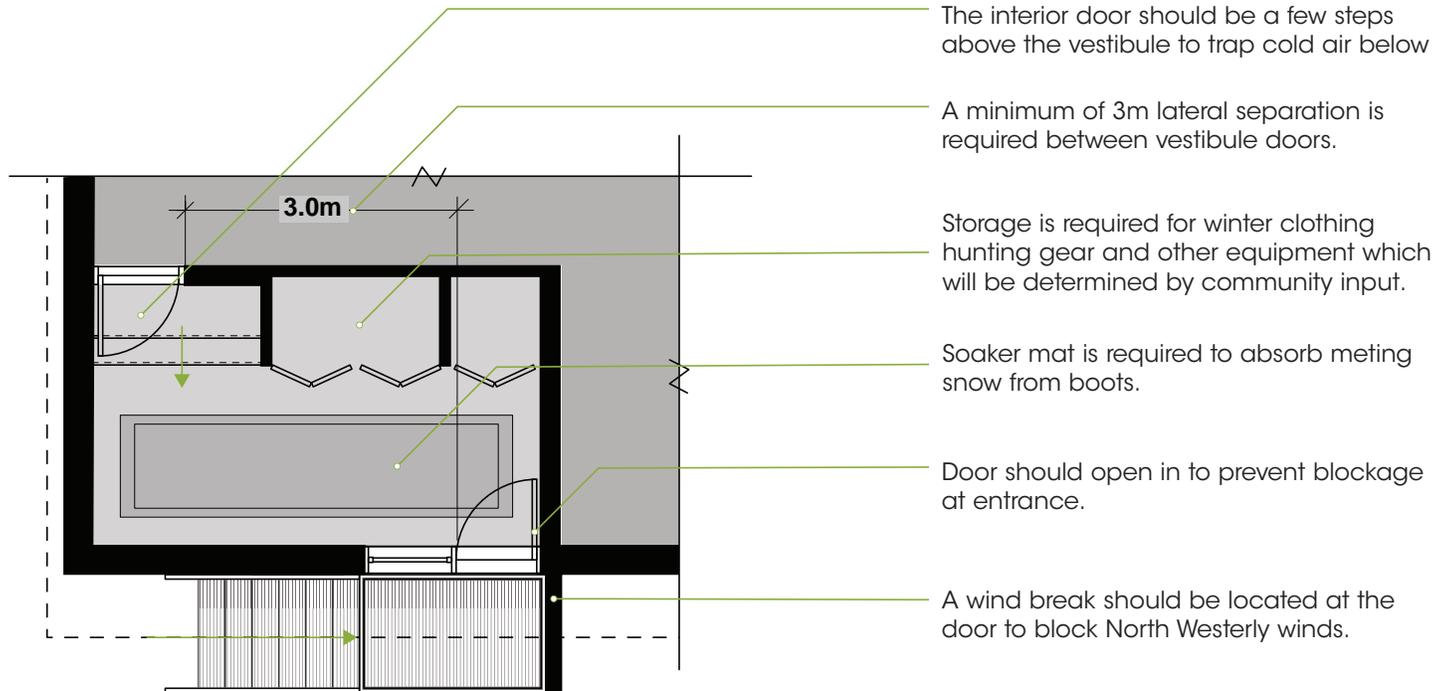


Figure 72 Entrance Vestibule Plan

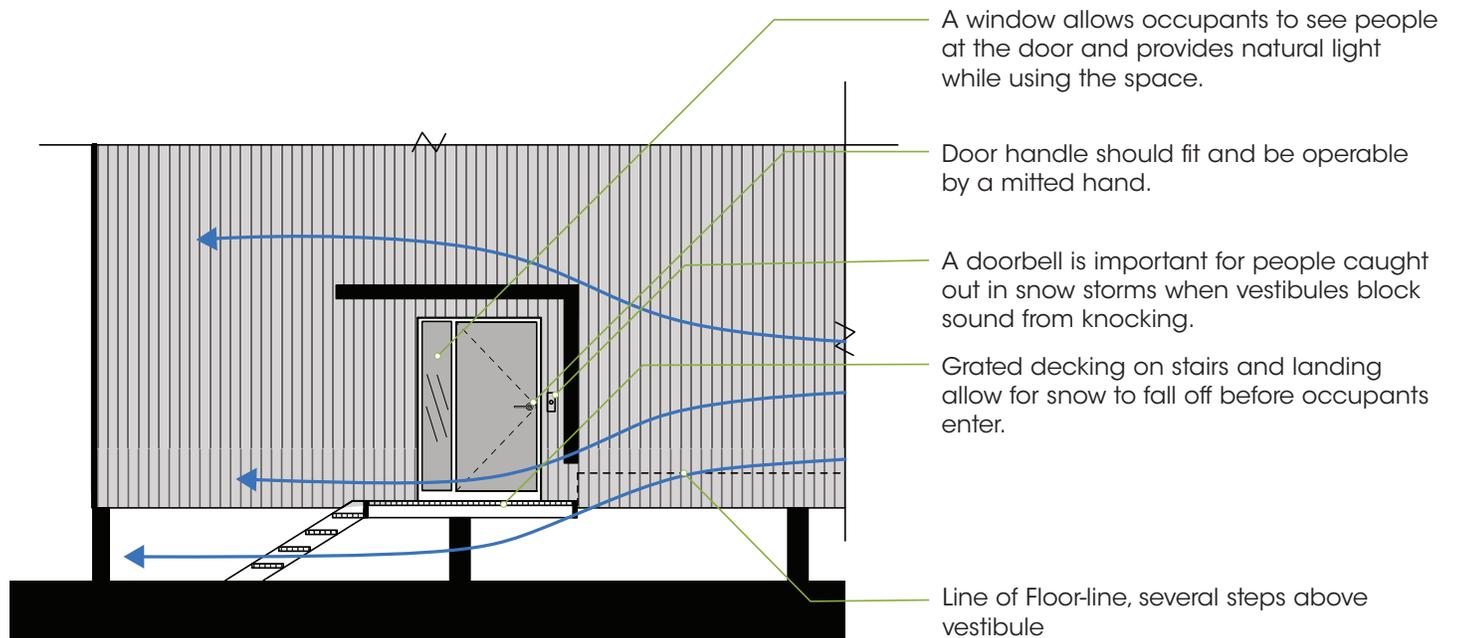


Figure 73 Entrance Vestibule Elevation



VESTIBULES IN DÉLINE



Figure 74 Removed Door in "Cold" Porch/Vestibule

- Vestibules in Déline can be both hot or cold but in either case there is usually a warm space with storage for clothes to allow occupants to get dressed in comfort.
- Frost heaving can cause differential settling of vestibule to the home as they sometimes have different structural systems.
- There is often a 90 degree turn between the vestibule and the main living space to prevent a draft. One home that did not, had one added by the owner shown in Figure 72.
- Precipitation is low in Déline, reducing issues of snow build up at the entrance and snow falling off the roof onto the deck. These were not issues cited by community members.
- Storage for outdoor equipment is often spread between the vestibule, the entry way and a storage or utility room. If appropriate space is not allotted to storage it begins to occupy other areas such as kitchens.

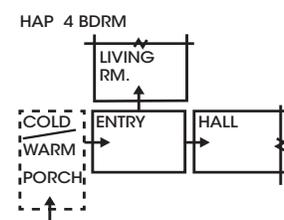
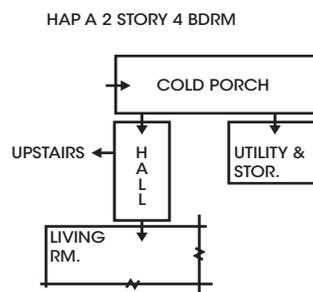
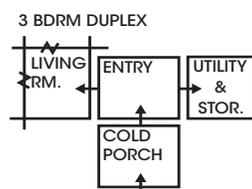
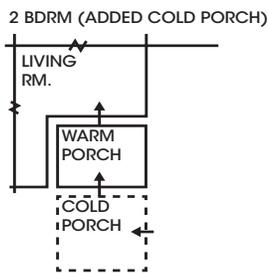


Figure 75 Vestibule Configurations

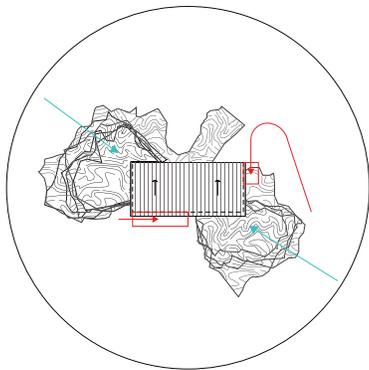


Figure 76 Potential Snow Accumulation Around Entrance

RECOMMENDATIONS

- In most cases entrances should not be placed on the south facade as they require a canopy which may prevent sunlight coming into the home as it reaches its highest point in the sky.⁴⁶
- Doors should open inwards to avoid snow pack blocking entrance ways.
- Vestibules should sit approximately two steps lower than the living area beyond to trap cold air.
- A warm vestibule is preferred over a cold one by the people in Déline. To ensure the airlock effect of the vestibule is preserved, there should be a warm space provided to get dressed in creating an airlock transition between inside and out.
- Doors in the vestibule acting as the airlock should either be rotated 90 degrees relative each other or be offset by three meters to reduce drafts.
- A windbreak and canopy at the entrance will improve airlock function and make entering and exiting easier. (See Figure 73)
- Figure 76 illustrates potential snow accumulation for Déline which is not presently an issue but may become problematic in the future as precipitation is predicted to increase. Steady northern winds, although less frequent to WSW and ENE winds, may deposit snow to the south of the building.

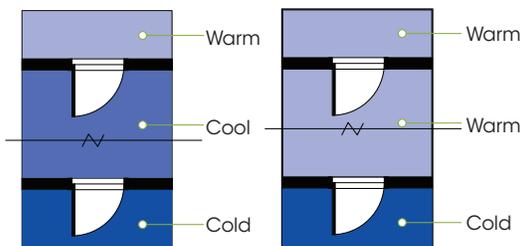


Figure 77 Heated Vestibule (right)
Unheated Vestibule (left)

5.3 OWNER ALTERATIONS & RENOVATIONS

Home Alterations and Renovations

- Wind blocks are added to decks and attached to vestibules, often made of siding or plywood.
- Wood pattern vinyl flooring is often added atop the original vinyl tile.
- Oil burning Toyo stoves in the main living area are added to supplement furnace and/or a wood burning stove.
- Uninsulated cold rooms are added, for skinning and storing animals, with doors into the home and to outside for bringing large game directly into cold rooms. Rooms often have open stud plywood interior walls a window and a chest freezer.
- Additional airlock enclosures are often added to original vestibules to account for inadequate distances between or the lack of perpendicular differential in vestibule doors.
- Vestibules are often missing the innermost door, removing airlock function and resulting in heat loss. This alteration is usually made to create a warm space in which to dress for cold winter weather.

Yard Structures and Objects

- Tipis for smoking fish and cooking in the warmer months, made of stripped spruce poles clad in plywood around their base and canvas or tarp around their top.
- Sheds used for workspaces and storage, made from recycled plywood crates used to transport housing materials.
- Vehicles including boats, RVs, ATVs, snow-mobiles, sleds and trucks, see Figure 81.
- Various other objects such as barrels for fires or storage, sheet goods, building products, tables for skinning animals or cleaning fish, picnic tables for outdoor dining, and other land based lifestyle equipment.



Figure 78 Cold Room and Chest Freezer



Figure 79 Addition to Vestibule



Figure 80 Plywood and Canvas Cooking Tent

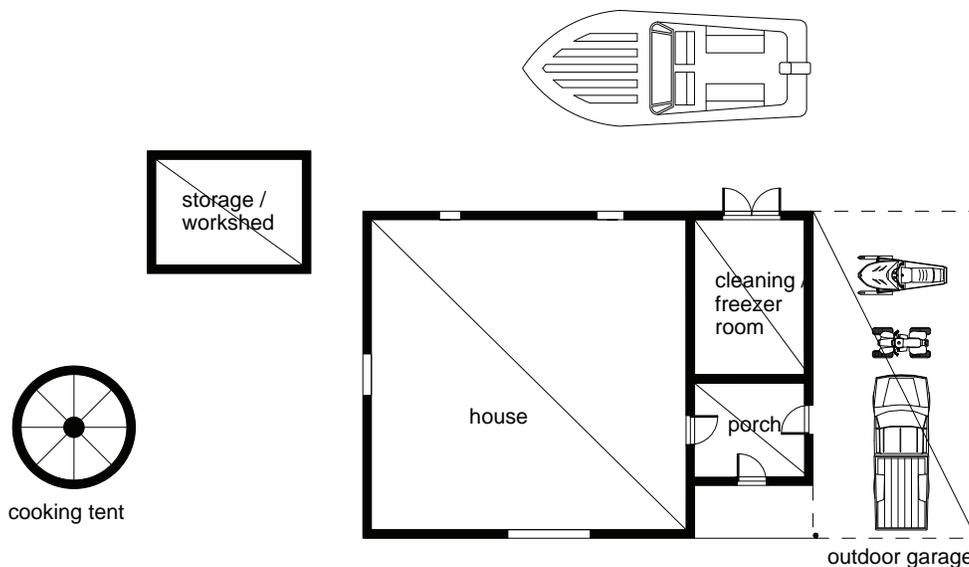


Figure 81 Additional Elements to Home and Yard

5.4 DEFICIENCIES & REOCCURRING ISSUES



Figure 82 Differential Settlement of Front Deck



Figure 83 Water Damage on Window Sill

ANTICIPATE

- Frost heaving effects newer constructions such as the duplexes and Traditional Knowledge building on the northern side of the community due to poor soil and minimal or no site pre-loading.
- Decks heave relative to the homes due to a lack of deck foundation or the use of a different foundation type from that of the home as seen in Figure 82.
- Furnace boilers break down often with hydronic furnaces have fewer issues.
- HRVs are unplugged frequently by occupants due to noise and energy loads.
- Moisture, ice and snow build up around sewer vents causing foul odors to enter the home.
- Pipes leading to septic tanks freeze especially when tanks are located farther from the source. It is important to locate this directly adjacent to outdoors. Some duplexes have had the sewer tank pipes mixed up with the left unit's waste going to the right sewer tank and vice versa, according to one community members testimony.
- Moisture damage occurs on window sills due to condensation.
- Broken windows in a small number of homes and multi unit dwellings.
- Cold floors occur in homes with crawlspaces likely caused by thermal breaks in the crawlspace floor.
- Damaged water intake valves are caused when they are struck with a wrench to free caps from ice buildup.
- Water tanks overflow during fill ups creating frozen areas around the house.
- Gypsum board walls are difficult and expensive to repair due to lack of materials resulting in disrepair.
- Doors in vestibules are often removed inhibiting the effectiveness of an airlock.

5.5 COMMUNITY ENGAGEMENT & INPUT



Figure 84 Community Layout and Housing Charette Drawings

Introduction

Community input was gathered through informal conversations with community members over coffee in the band office lobby and over food at one of the cookouts held in the tipi at the traditional knowledge center. The informal gathering of information put us in contact with demographics less involved in leadership such as women and children. Input was also gathered in more formal environments, particularly the band office chambers where four input sessions took place covering governance, funding, sustainability, innovation, housing design, community planning, culture and tradition.

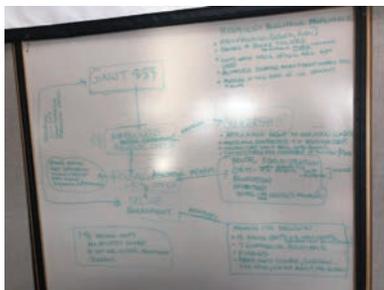


Figure 85 Governance and Funding

Societal Recommendations

- Conversations revealed many community members to be living in crowded housing conditions. One example was a working family of four living in a 900 sq ft two bedroom unit.
- The HAP (Home Ownership Assistance Program) houses came up frequently in conversation as a sought after and well performing model, see Appendix page 65 for images.
- Socializing in homes and events such as social prayer throughout the month of May should be accommodated in the design.

Technical Recommendations

- Multi unit residential building entrances cannot be directly adjacent as neighbours will disturb each other. This was a major factor in the abandonment of the multi-unit residential complex.
- The housing design and community layout input session focusing on the multi unit residential building informed us that:
- Elders and singles are the demographic requiring single bedroom units. The elderly may require their own complex as there is concern regarding elder abuse.
- Shared common areas including a large cooking tent or something equivalent should be incorporated into the project.
- Individuals also require space to store game meat, repair vehicles and store outdoor equipment such as ski-dos, ATVs, and boats.
- Shared mechanical space between 4 units is an effective way to increase maintenance efficiency.

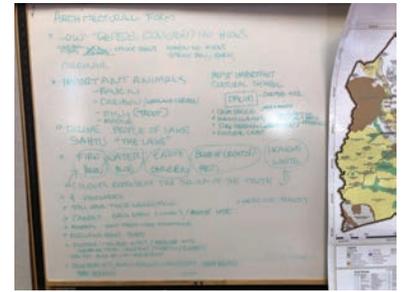


Figure 86 Community Engagement - Innovation and Sustainability

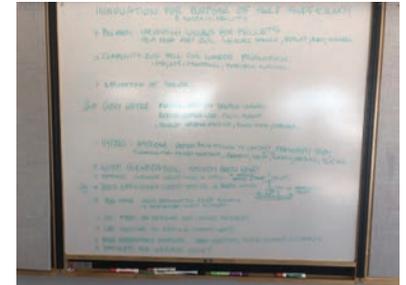


Figure 87 Community Engagement - Culture and Tradition

5.6 HOUSING NEEDS

Introduction

A waiting list of twenty-seven people looking to move out from families homes or overcrowded living situation illustrates the need for housing in Déline. The most demand exists for single bedroom units. Despite the housing shortage there are some units in the community that are abandoned, many of which are in such a state of disrepair as to be economically unfeasible to repair. The project seen in Figure 85 is a multi unit complex of single bedrooms apartments, abandoned due to social issues such as excessive partying. This was promoted by the proximity of entrances and the open area in front of the complex.

Housing Waiting List.

- 1 Bedroom Units 20 People
- 2 Bedroom Units 4 People
- 3 Bedroom Units 3 People

Demographics that require 1 bedroom units are elders and young people.

- Elders should have their own housing complex as there are concerns of elder abuse.
- Young people's housing should address issues such as drinking and partying which caused the previous 1 bedroom multi-unit complex to fail.

Recommendations

Based on the housing wait-list the design prototype that will be pursued in the next phase of this project will be a multi-unit complex of detached single bedroom units. The focus of our design will be to ensure this model functions in an environmentally, financially and culturally sustainable way.



Figure 88 Abandoned Multi-Unit 1 Bedroom Complex

5.7 SUSTAINABILITY AND INNOVATION

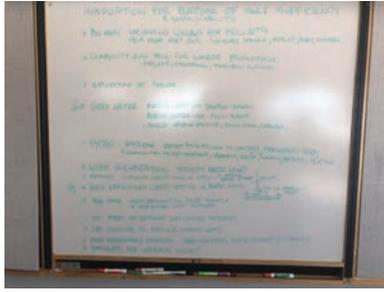


Figure 89 Community Engagement - Sustainability and Innovation

Introduction

Ideas on sustainability were gathered in a meeting with policy makers and housing experts with the goal of understanding what direction Déline is heading, what opportunities have been explored and what approaches could benefit the community most effectively.

Recommendation

- Solar Panels produce the most energy in the summer when the least demand exists and produce little energy in the winter when it is most needed. There is one solar array on an industrial building but there was no information on its effectiveness. There is evidence to suggest that solar and wind energy availability complement each other, but this does not account for the drastic fluctuation of demand between winter and summer. It is however a viable supplement to existing energy producers especially when considering bi-facial solar cells and the reflectivity of snow, and when combined with wind options.⁴⁷
- A Wood stove, fan and ducting system is a scheme that would allow occupants to move an inexpensive heat source around their home and improve ventilation.
- The development of a sawmill for producing local wood for housing and pellets for heating is a strategy which could build local resilience and reduce transportation requirements.
- Grey-water recycling could reduce the amount of water used and the number of water tank refills and sewage tank pump-outs that must occur each week. Grey water systems will also reduce load on the sewage lagoon and pumping station which are susceptible to damage from climate change. Maintenance may be an issue and must be properly addressed.
- Under floor hydronic heating combine with ERV or HRV are a potential heating and ventilation strategy however HRVs are often unhooked by tenants complaining of noise and energy loads.
- A hydro-electric power generating station was explored but halted due to a cost of 5-6 million dollar price tag for feasibility. Akatchu, Sahtu, Déline, Datcho & Tlicho communities joined together to form a franchise in this endeavor.
- High performance envelopes should be used to lower energy requirements and include triple glazed windows.
- LED lighting would lower electricity cost and bulb requirements.
- Wind Generation could harness a steady Northerly wind and as mentioned above compliments available solar energy.⁴⁸
- Passive heating is another supplement to standard heating systems. In the First Nations community of Whati, approximately 300km South East of Déline, passive heating is saving owners 25%-50% on heating costs compared to those homes built without passive strategies. This is a significant cost savings when electricity costs \$0.78/kWh or on average \$966 per month for the average household in NWT. (Fowler 30)

5.8 PROPOSED PASSIVE HOUSE STRATEGY

PASSIVE HOUSE STRATEGY

As we see in figures 90 through 92, our passive house strategy focuses on insulation flowing as a continuous line along the exterior of the building causing the wall and roof to begin to take on similar properties. Figure 52 illustrates the wall assembly continuing into the roof to form a cathedral ceiling which gives the entire envelope a similar sectional composition.



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Deline 2x4/ Neopor

Exterior wall

Exterior Wall
2x4/ Neopor 032

Thermal protection

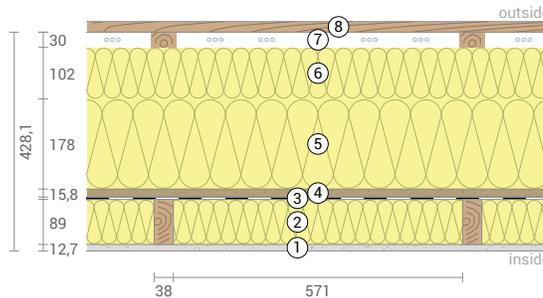
$U = 0,09 \text{ W/(m}^2\text{K)}$ (R63)

Moisture proofing

Drying reserve: 1336 g/m²a
Dries 1 days
Condensate: 6,9 g/m²

Heat protection

Temperature amplitude damping: 20
phase shift: 10,8 h
Thermal capacity inside: 24 kJ/m²K



- ① Plasterboard (12,7 mm)
- ② Glasswool (89 mm)
- ③ PE foil
- ④ Plywood (15,8 mm)
- ⑤ Neopor WLG032 (178 mm)
- ⑥ Neopor WLG032 (102 mm)
- ⑦ Rear ventilated level
- ⑧ Siding

Deline Suspended Floor

Floor

Thermal protection

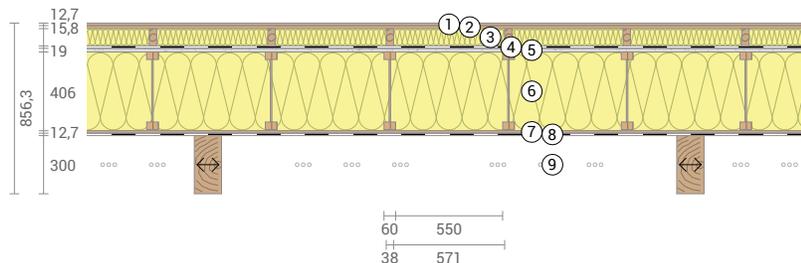
$U = 0,08 \text{ W/(m}^2\text{K)}$ (R71)

Moisture proofing

Drying reserve: 1050 g/m²a
Wood moisture: +0,1%
Dries 1 days

Heat protection

Temperature amplitude damping: >100
phase shift: non relevant
Thermal capacity inside: 63 kJ/m²K



- ① Lamination (12,7 mm)
- ② OSB (15,8 mm)
- ③ Glasswool 040 (89 mm)
- ④ PE foil
- ⑤ Plywood (19 mm)
- ⑥ Cellulose (406 mm)
- ⑦ OSB (12,7 mm)
- ⑧ Breather membrane sd=0,1m
- ⑨ spruce (300x140)



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Deline Roof System

Roof construction

Roof System 2x8 Lumber

Thermal protection

$U = 0,08 \text{ W/(m}^2\text{K)}$

(R73)

excellent insufficient

Moisture proofing

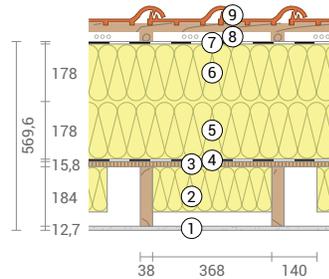
Drying reserve: $76 \text{ g/m}^2\text{a}$
(leads to devaluation)
No condensate

excellent insufficient

Heat protection

Temperature amplitude damping: >100
phase shift: non relevant
Thermal capacity inside: $48 \text{ kJ/m}^2\text{K}$

excellent insufficient



- | | | |
|---------------------|--------------------------|--------------------------------|
| ① Drywall (12,7 mm) | ④ PE foil | ⑦ Breather membrane $sd=0,05m$ |
| ② Joists (184 mm) | ⑤ Neopor WLG032 (178 mm) | ⑧ Rear ventilated level |
| ③ OSB (15,8 mm) | ⑥ Neopor WLG032 (178 mm) | ⑨ Dachziegel inkl. Lattung |

Neopor IS3000 and IS4000 insulation is an exo-skeletal exterior insulating panel system which provides a cost-effective thermal break to the building envelope to effectively retain heat and save on energy. This graphite polystyrene rigid foam insulation is a breathable, semi-permeable material providing an opportunity for moisture "to dry out", starting dry and staying dry. This low mass insulation sustains R-values throughout their life cycle with IS3000 and IS4000 values of R- 19.1 and R-32.37 respectively not experiencing the thermal-drift seen in extruded polystyrene as Neopor uses pockets of air and not fluorocarbons.

Neopor has environmental and cost benefits as well as the comfort and energy savings performances listed above. These include a 50% reduction in raw material from products providing comparable R-values, a 30% thinner profile compared to similar R-values, a low global warming potential and a low mass, reducing transportation costs.

Overall R-values for Walls, Roof and floor are R63, R73 and R71 respectively providing an excellent energy efficiency rating which would experience payback after three years of energy savings under normal circumstances. Within the context of Deline, transportation costs and a reliance on fossil fuels to heat homes this timeline should be accelerated and would provide relief from fossil fuel dependency for the community.

Triple pane windows are specified to reduce heat loss, where the interior pane sits at the interior face of the wall to manage condensation build up. A heater and intake air vent below and separate from the window work to move air back into circulation.

Energy Well, located in Yellowknife has the expertise and experience to source these materials and set up a pre-fabrication facility. This would bring business to the region while also providing an opportunity for community members to take part in the pre-fabrication process, learning a skilled trade, creating much needed employment, and embedding a sense of proud ownership in their built environment.

5.9 BUILDING FORM & MASSING

Introduction

Massing strategies should attempt to address key climactic conditions such as the importance of heat retention, wind direction, snow accumulation, ice damming, solar gain, volume, and footprint. Explorations in building form and massing are laid out in detail but should always be informed by a simplicity of the building envelope, construction material cost, transportation methods for construction materials and the lifestyle of the buildings inhabitants in relation to local and seasonal climactic conditions.

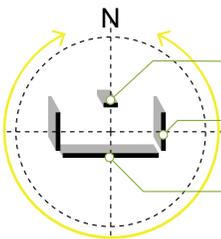


Maximize Volume to Surface Area ratio.
A sphere is optimal but not necessarily livable.

vs.



While a High Volume to Surface Area ratio is optimal for minimizing heat loss it is not necessarily optimal for Solar Gain.



Minimize Northern Facade.

East and West Facades should have the capacity to absorb sun as they do receive exposure due to the high azimuth range.

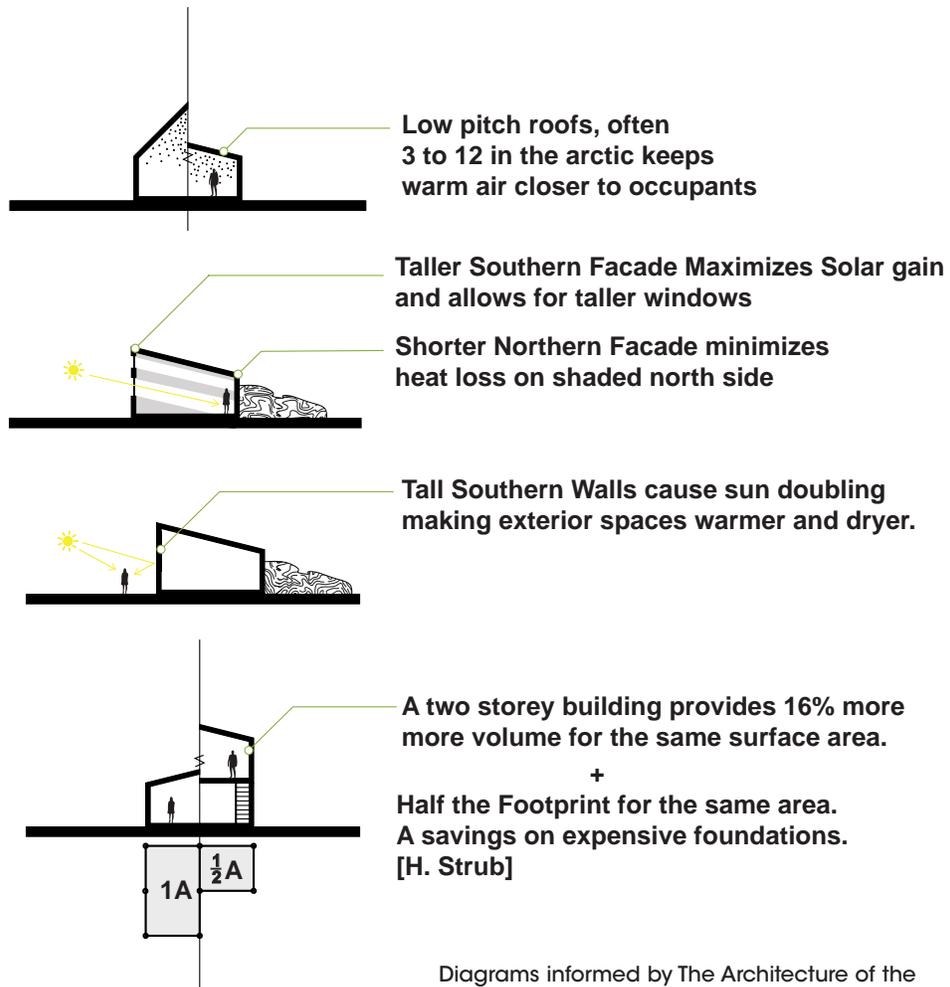
Maximize South Facade.



Valleys and hip roofs should be avoided as they create ice damming.



Eaves and overhangs create icicles which damaged roof edges and are dangerous to occupants and should be minimized.



Diagrams informed by The Architecture of the Circumpolar Region by MacTavish and White

Building Mass

- Building mass should have a high volume to surface area ratio since heat is lost through exterior surfaces. This ratio creates a deep interior space which, due to Déline's northern location, can still be lit naturally from the low sunlight.⁴⁹ See above for light penetration diagrams pertaining to this.
- Passive heating can be used to some extent but its effect is limited by the thermal mass of traditional far north building materials which are often quite low.
- A second story is an effective way to reduce required foundations and minimize the volume to surface area ratio, thereby saving on construction costs, maintenance and reducing heat-loss over the life of the building.

Envelope

- The envelope should be as tight and free from complexities as possible. This requires that soffits and eaves be kept to a minimum.
- The roof should contain no valleys as they tend to cause ice damming. The shed roof is preferential in Northern climates for its simplicity and ability to control drainage and snow.⁵⁰
- The roof should rise to the South and fall to the North, creating one continuous plane, free from joints creating a single surface for snow and water to shed North, the least used exterior space in most cases.
- Roof pitch should be a low slope to decrease redundant volume and keep heat within occupancy height.

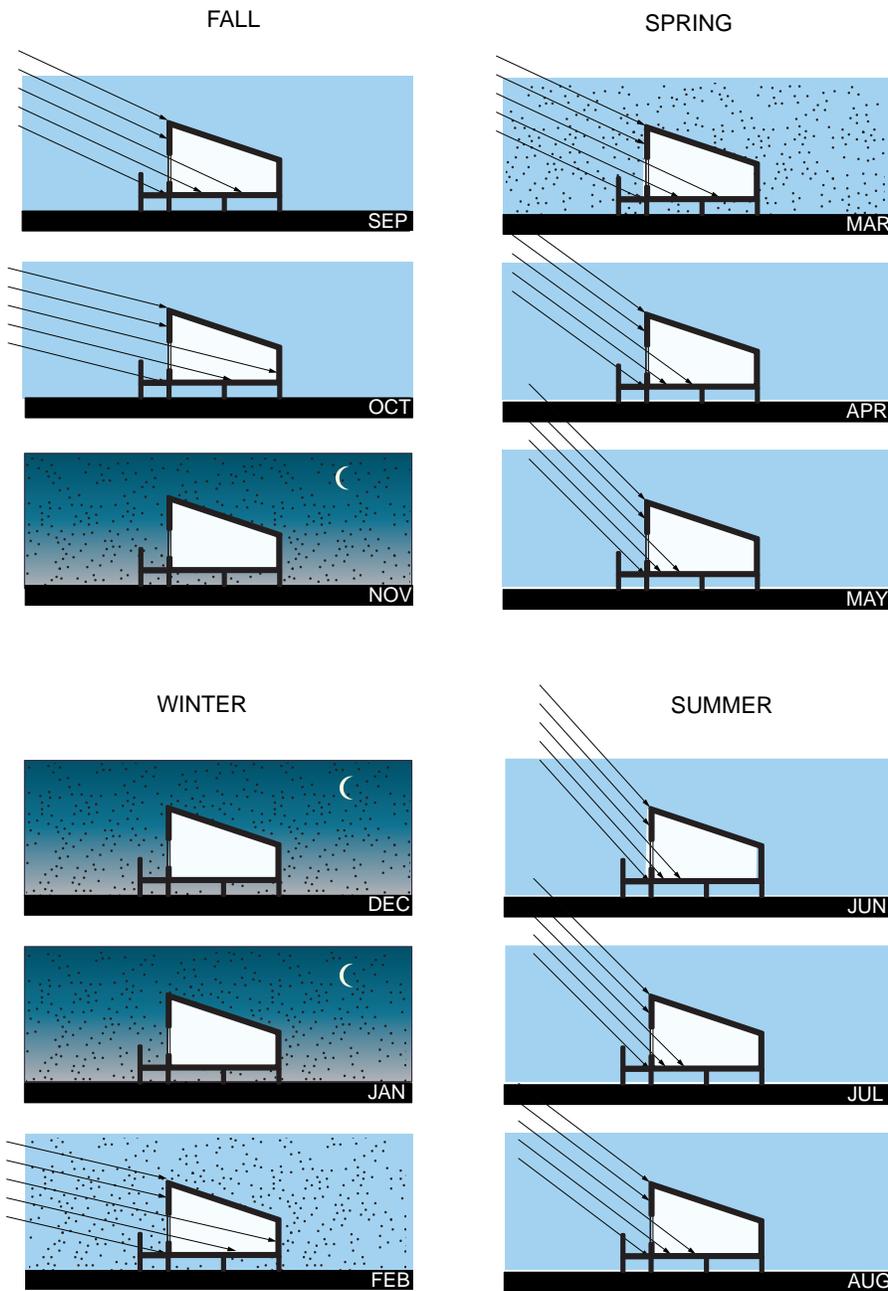


Figure 90 Sun Angles at 1300hrs Given A Southern Exposure.

Sunlight and Solar Gain

- The home is drawn as having a standard 6m depth, with a basic sloped roof to the South.
- The sub Arctic winter sun, as it travels at a low angle in the sky infiltrates deep into the building.
- To maximize solar exposure the house should be oriented slightly to the West of solar South therefore giving the home the maximum amount of sunlight possible.⁵²
- Homes can use passive solar gain to reduce heating and lighting costs but may overheat in the summer. A sunshade should be provided to avoid this.



5.10 1 BEDROOM UNIT PROPOSED MASSING

The proposed massing focuses on key concepts learned from research and conversation with the community. It features a high volume to surface area ratio to reduce heat loss, with a tight envelope free of complexity. A shed roof acts to control precipitation, minimizes valleys reducing an opportunity for ice damming and eliminates unnecessary eaves and soffits. The massing also functions well with the aesthetic of the log cabin which the community is so fond of.

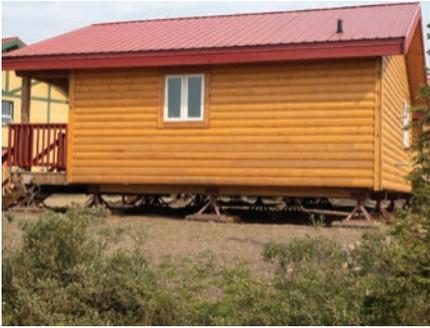


Figure 91 The community feels connected to the log cabin type



Figure 92 This aesthetic is combined in our design with a passive house envelope



SHED ROOF OPTION



BUTTERFLY ROOF OPTION



PITCHED ROOF OPTION

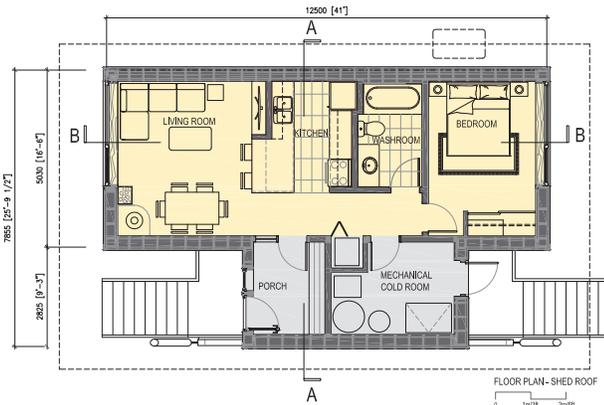
Figure 94 Exterior renders of 3 options



CUT AWAY PLAN PERSPECTIVE



PERSPECTIVE VIEW



FLOOR PLAN - SHED ROOF



PERSPECTIVE VIEW ENTRANCE

Figure 95 Presentation drawing option A

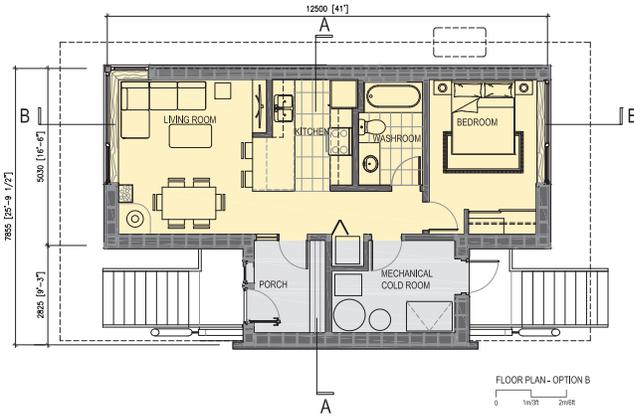


Figure 96 Presentation drawing option B

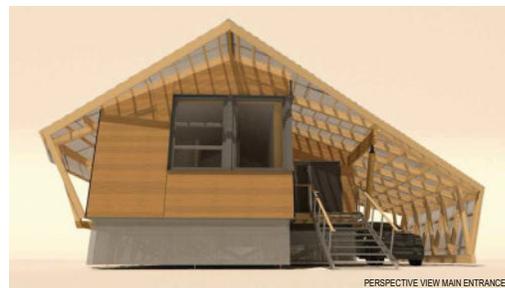
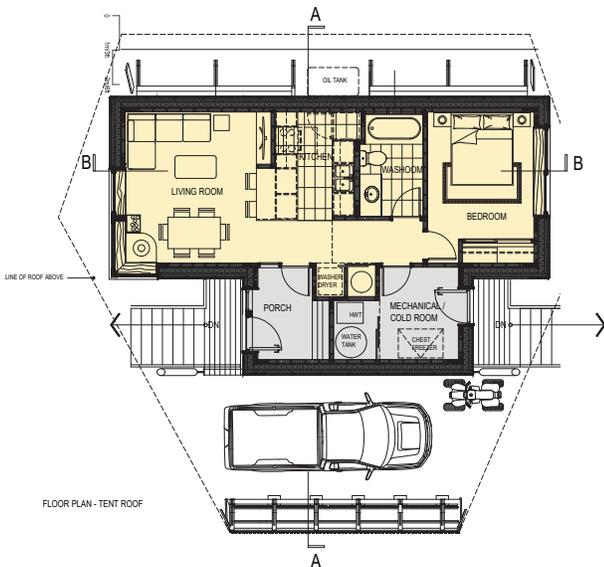
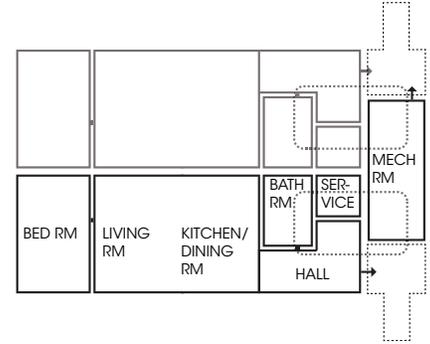


Figure 97 Presentation drawing option C

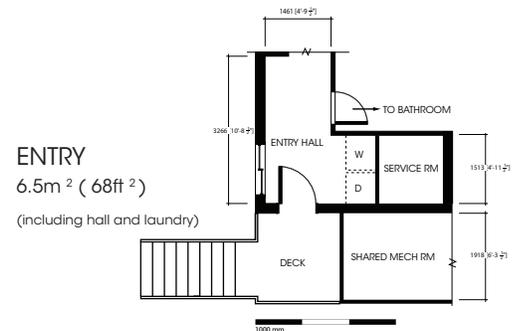
5.11 PROGRAM ANALYSIS OF EXISTING BUILDINGS

1 BEDROOM DUPLEX

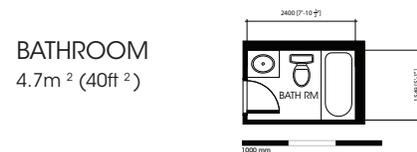
- 1 Bedroom duplex have interconnected kitchens, dining rooms and living rooms.
- Septic tanks sit beneath the bathroom service room and mechanical room.
- Sinks and toilets are located to the left of the sewage tank for a short travel distance.
- The 1 bedroom duplex is arranged in a linearly as an elongated rectangle which hinders control over natural lighting and solar orientation and creates a long wall on the interior which can have no windows.



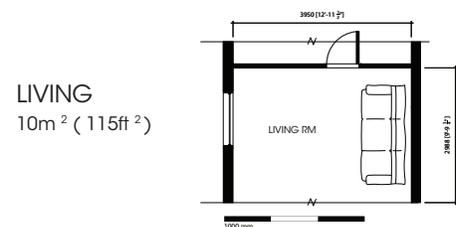
- Entry space relies on a single door to separate interior from exterior which will cause heat loss.
- Storage at front entrance is not provided for outdoor equipment as the area to the right of door is reserved for laundry.
- Mechanical room services both units and is located adjacent the entrance, accessible through a single door.
- Service rooms are accessible through the mechanical room and a small interior door.



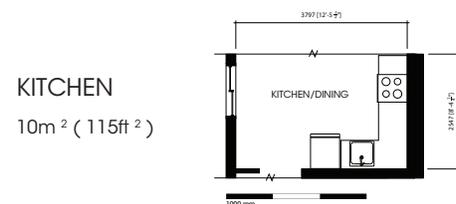
- 3 piece bathroom is located off the Entry hallway, adjacent to the service room and mechanical room for access to water.
- There are no windows in this space as it is located along the wall adjoining the duplex units.
- Toilet is located close to an elongated sewage tank which allows an inlet farther into the home and an outlet at the exterior wall.



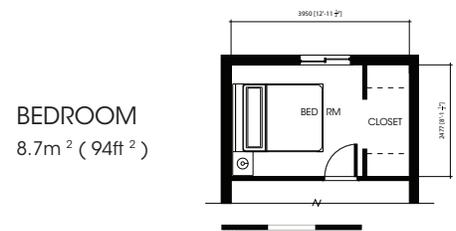
- Living room is very small but is open to the kitchen and dining area which will make it feel larger.



- Kitchen and dining space face into a corner.
- Natural light must come from outside wall window and there are no views to the exterior while working in the kitchen.

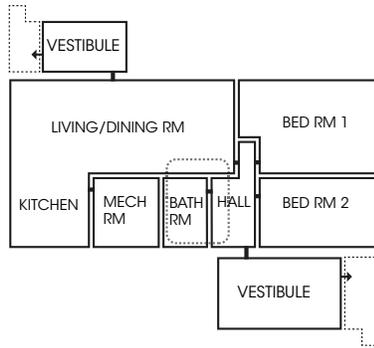


- Bedroom is shown with a queen sized bed and side table fitting snugly into room set across from a built in set of closets.
- The closets are small given the amount of outdoor clothing and equipment required by the climate.





2 BEDROOM HOME OWNERSHIP ASSISTANCE PROGRAM D

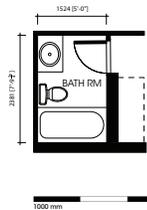


- This home has two vestibules and a compact floor plan with a tightly packed but generous hall in terms of width.
- The connected living room, dining room and adjacent kitchen create a generous living space.



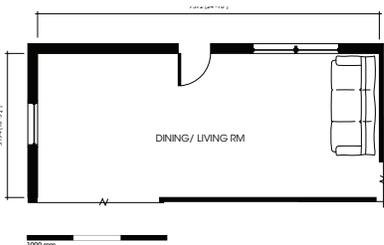
ENTRY
5.9m² (59ft²)

- One vestibule enters into the main living space and a second vestibule exits from the back hall.
- The front vestibule is equipped with a closet but since many Déline residents prefer a warm space to dress in may cause residents to remove a door to keep their clothing warm.
- The rear vestibule seen in the above left space sequence diagram could be elongated to connect to the kitchen and provide the double function of vestibule and cold room for skinning animals.



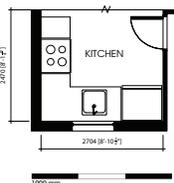
BATHROOM
3.9m² (42ft²)

- Bathroom is located immediately over the septic tank, adjacent the mechanical room providing maximum proximity of toilet to septic and all fixtures to the water tank.
- Bathroom does not have windows despite the fact it is located on an exterior wall.



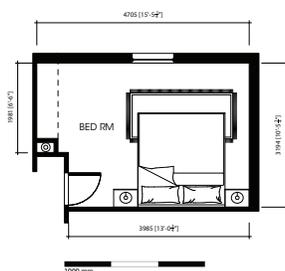
LIVING
26m² (285ft²)

- The large living space is lit by two windows to the north and west of the drawing and a clerestory which brings light into the center of the room.
- An allocated area for dressing in a warm space would be beneficial at the vestibule door and should include storage.
- A warm dressing area will function better as an airlock if the door is located closer to a corner of the room or perpendicular the exterior door.



KITCHEN
7.3m² (79ft²)

- Mechanical room access is adjacent to the kitchen.
- There is natural light and a view provided to occupants in the kitchen.
- The separation of kitchen from dining area makes the kitchen space feel small in contrast to other examples given here.



MASTER BEDROOM
13.4m² (144ft²)

- The master Bedroom is drawn with a king sized bed and two end tables.
- This bedroom is large enough that there could be a small dresser or other storage unit added to the East side of the North wall.

3 BEDROOM ACCESS

- The 3 bedroom home has proportionately similar length and width of exterior walls with the main spaces organized around a T-shaped hall.
- The septic Tank is located far away from the kitchen and bathroom due to its position in heated a crawlspace.
- This home has its water in the crawlspace under bedroom 1 with long travel distances to the kitchen and bathroom.

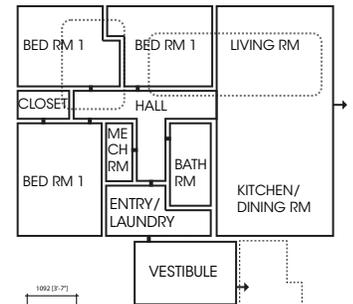
- Entry is long and tight requiring the occupant to travel through the vestibule, entry/ laundry room, then turn through a hallway to enter the main living space.
- The lowered floor in the vestibule and extra doors in the entry/ laundry room thoroughly breaks the interior and exterior environment.
- Entry/Laundry room has storage for coats and boots in a warm area for occupants to dress in comfortably.
- There is a small amount of storage space located to the right of vestibule's interior door for winter gear.

- 3 piece bathroom located in the center of the home equal distance from all bedrooms and the living space.
- Located far away from sewer and water tanks.

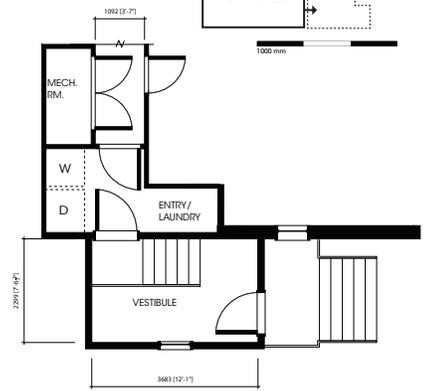
- Living room is directly connected to kitchen and dining room to making the spaces feel larger.
- Space is lit from three sides by four windows to provide natural lighting.
- Exterior door from living room opens directly to the outside which, if used, would be uncomfortable for occupants during the winter.

- Kitchen is lit with two windows.
- The window over the kitchen sink faces the porch allowing occupants to easily see people coming.
- Kitchen sink and water tank are located in opposite corners of the home.

- Master Bedroom is drawn with a king sized bed and two end tables fitting easily across the room.
- Additional storage units such as a bookshelf or dresser could tightly fit in the top left and bottom right of the room.



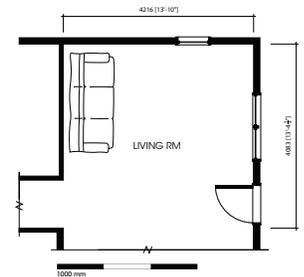
ENTRY
12.5 m² (145ft²)



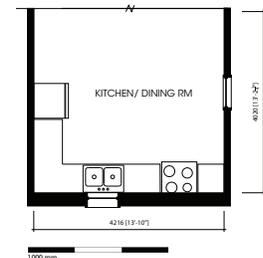
BATHROOM
3.8 m² (41ft²)



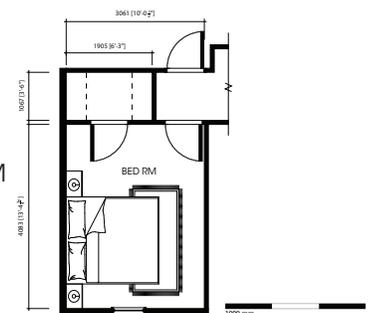
LIVING
14.4 m² (155ft²)



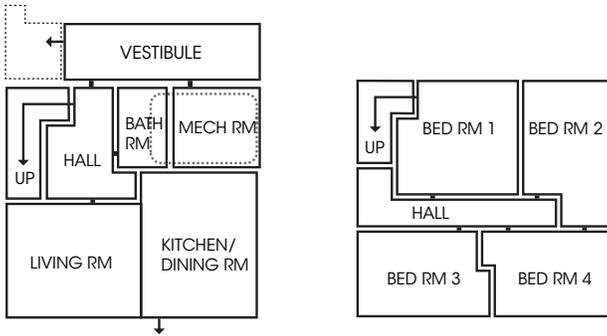
KITCHEN
14.2 m² (153ft²)



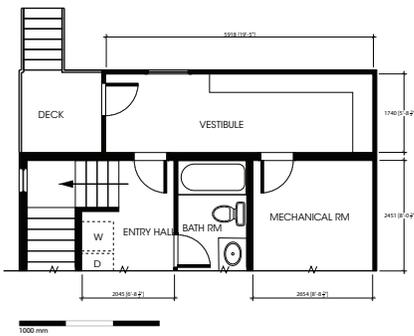
MASTER BEDROOM
12.7 m² (137ft²)



4 BEDROOM HAP A [2 STORY]

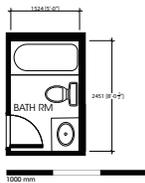


- 2 story 4 bedroom home has a larger amount of space occupied by hallways and stairs than other home types given here.
- Bathroom kitchen and water tank are all located in close proximity to each-other.



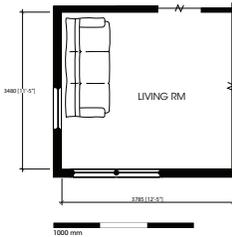
ENTRY
 14.8m² (160ft²)
 (Entry Hall and Vestibule)

- Vestibule is elongated with doors to the mechanical room and entry hall.
- Entry hall doubles as laundry room.
- Vestibule is cold with a large storage space
- There is little warm space to store clothes in the entry hall before exiting through the vestibule.



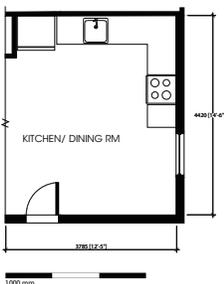
BATHROOM
 3.4m² (37ft²)

- 3 piece bathroom is on the main floor while bedrooms are on the second. Vertical separation may cause inconveniences.
- Toilet is stacked directly over sewage tank and bathroom fixtures are located adjacent the mechanical room for a short travel distance for water and sewage.



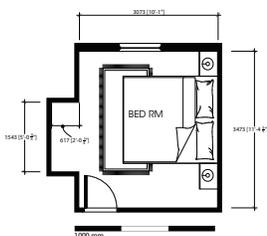
LIVING
 13.5m² (145ft²)

- Living room and kitchen space has light from three sides.
- Living room is smaller than the "2 Bedroom HAP D" despite the fact this unit has four beds.



KITCHEN/DINING
 13.5m² (145ft²)

- Kitchen exits directly to the exterior with no vestibule. A skinning room/ vestibule would be ideal outside of this door.
- Sink is stacked against the mechanical room and nearly over the sewage tank for plumbing efficiency.
- Work space in kitchen has no direct access to a window.
- Kitchen counter and fridge run flush with the living room wall creating a smoother transition from living room to kitchen.



MASTER BEDROOM
 10.6 m² (114ft²)

- Bedroom is shown with a king sized bed and two side tables. Storage space is very small, only 2' x 5' due to the linen closet taking up room to the left of the door.
- There is little room for additional storage units such as a bookshelf or dresser.

5.12 1 BEDROOM UNIT PROPOSED PROGRAM RATIONAL

This prototype developed from time spent getting to know families and community members through understanding their day to day patterns of living, as well as how these functions are aided or hindered by existing designs in the context of a cold regional climates.

The result is a home with a typical one-bedroom layout, with a compact kitchen-bathroom core to minimize plumbing runs, and a large living space for warm gatherings in view of the lake. To facilitate the land-based lifestyle of the community we have designed the mechanical room to provide space for the 350-gallon water tank, chest freezer and seasonal clothing. A warm vestibule with natural light and space to dress for going out on the land, lead out to a transitional porch under the translucent shed structure which features space for a car/truck, snowmobile, and quad. A passive envelope features R63 walls, R73 roof, R71 floor assembly, and triple glazed windows which in combination with minimal solar gains and wood fire heater provide a warm environment which reduces reliance on fossils fuels and lowers heating costs.

Aesthetically the character and form are derived from the community's affection for the log cabin, a land-based lifestyle, and the cold regional climate. Focus is given to views from interior living spaces and the creation of an inviting and communal landscaping with outdoor porches and benches. The shed roof provides ample parking, naturally lit, with ample storage space to facilitate this land-based lifestyle.

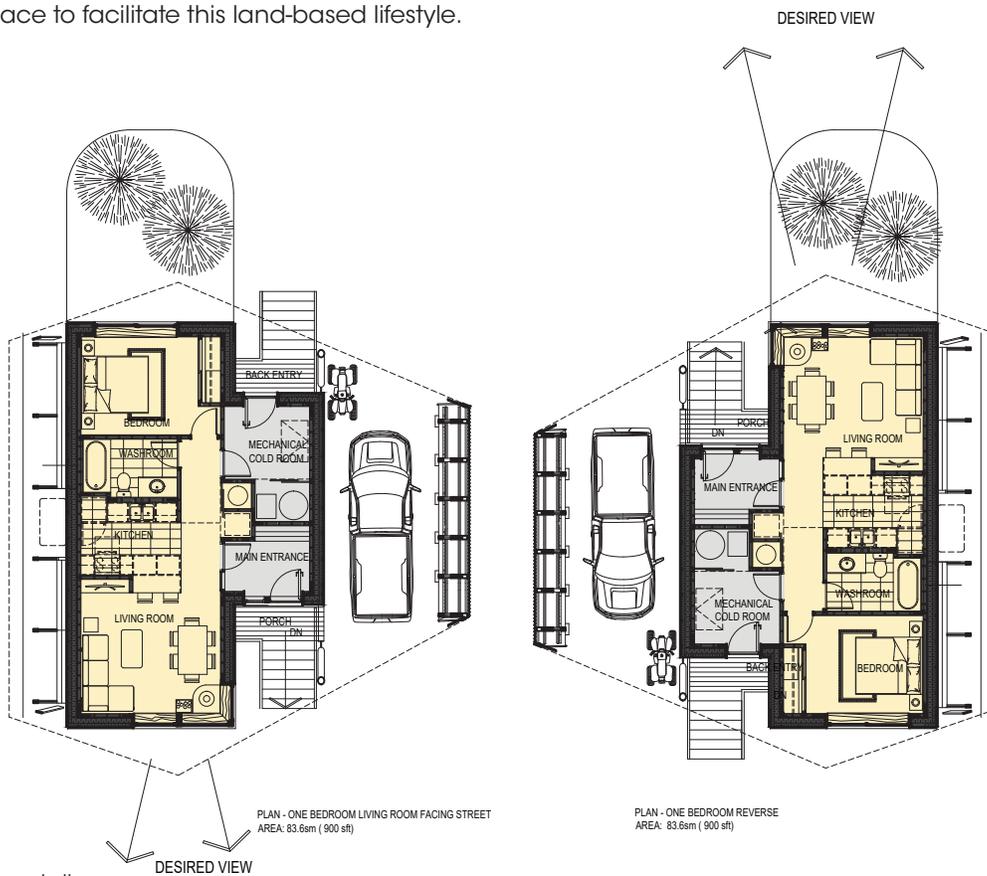


Figure 98 Plan layout diagrams



Figure 99 Interior Render



Figure 100 Interior Render

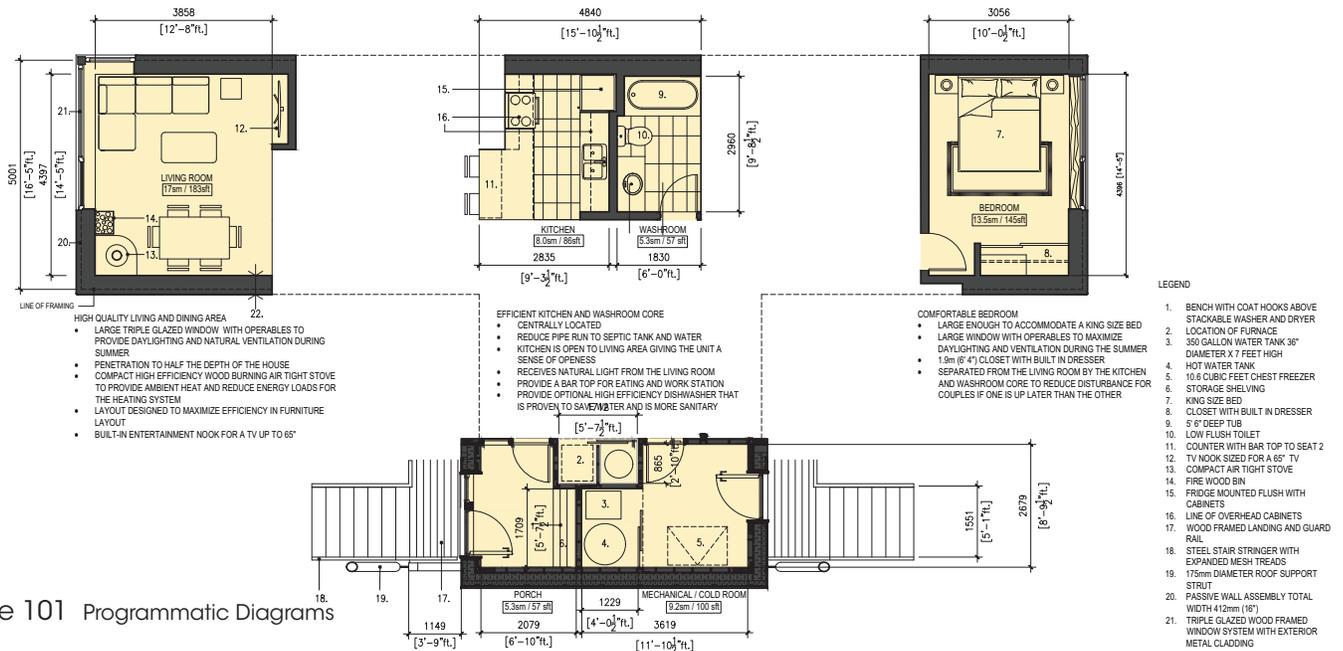


Figure 101 Programmatic Diagrams

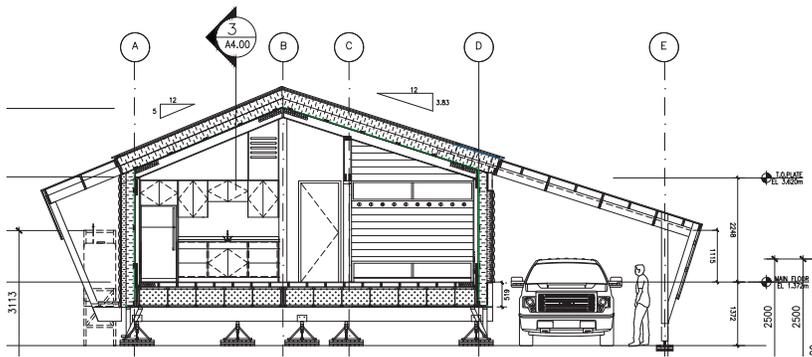


Figure 102 Section

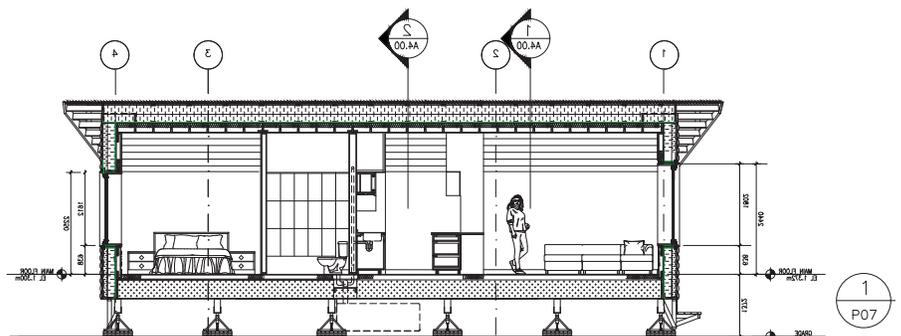


Figure 103 Longitudinal section

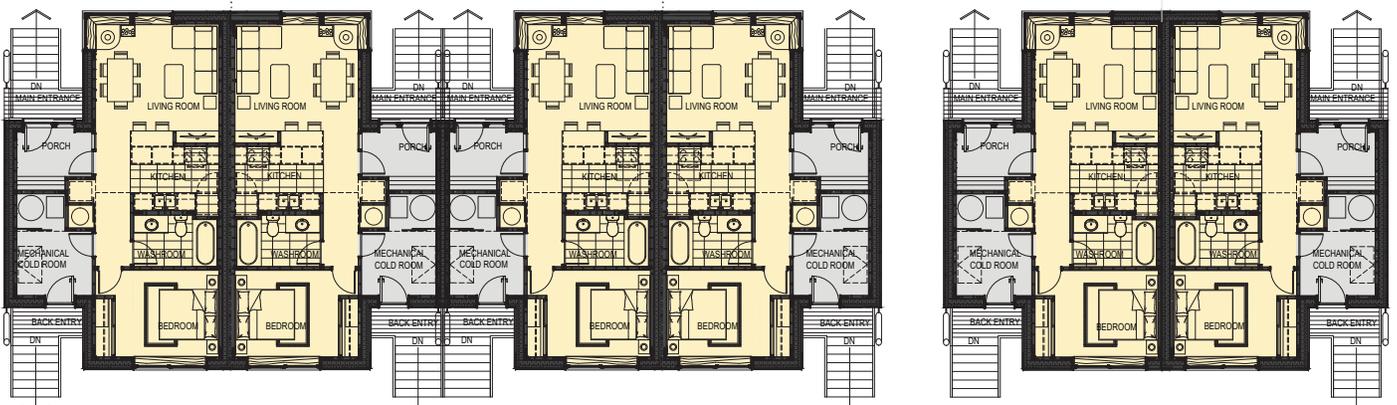


Figure 104 Duplex and Quadplex arrangements

PLAN - QUADPLEX
AREA: 334.4sm (3600 sqft)

PLAN - DUPLEX
AREA: 167.2sm (1800 sqft)

1 BEDROOM UNITS			TYPE 1		TYPE 2	
No.	Space Designation	Area (sm)	Area (sm)	Area (sft)	Area (sm)	Area (sft)
1	Heated Crawl Space	0.0	sm	0.0	sft	
GROUND FLOOR						
2	Entry Porch	0.0	sm	0.0	sft	
3	Entry Hall	4.3	sm	46.0	sft	
4	Living Room	10.7	sm	115.0	sft	
5	Kitchen	10.7	sm	115.0	sft	
6	Washroom	3.7	sm	40.0	sft	
7	Bedroom 1	8.7	sm	94.0	sft	
8	Mechanical Room	6.3	sm	68.0	sft	
9	Laundry	2.0	sm	22.0	sft	
10	Cold Porch	0.0	sm	0.0	sft	
11	Storage	0.0	sm	0.0	sft	
12	Hall	0.0	sm	0.0	sft	
SECOND FLOOR						
13	Bedroom 1	0.0	sm	0.0	sft	
14	Bedroom 2	0.0	sm	0.0	sft	
15	Washroom	0.0	sm	0.0	sft	
Total Net Program Area		46.5	sm	500	sft	
TOTAL GROSS AREA		54.8	sm	590	sft	

2 BEDROOM UNITS			TYPE 1		TYPE 2	
No.	Space Designation	Area (sm)	Area (sm)	Area (sft)	Area (sm)	Area (sft)
1	Heated Crawl Space	0.0	sm	0.0	sft	
GROUND FLOOR						
2	Entry Porch	3.2	sm	34.0	sft	5.5
3	Entry Hall	4.2	sm	44.9	sft	0.0
4	Living Room	20.0	sm	215.1	sft	26.5
5	Kitchen	5.3	sm	57.5	sft	7.3
6	Washroom	4.6	sm	49.0	sft	3.9
7	Bedroom 1	11.7	sm	125.7	sft	13.4
8	Bedroom 2	8.8	sm	94.7	sft	8.5
9	Mechanical Room	6.6	sm	71.2	sft	5.6
10	Laundry	4.2	sm	45.0	sft	4.6
11	Cold Porch	0.0	sm	0.0	sft	9.2
12	Storage	1.6	sm	17.0	sft	0.0
13	Hall	3.3	sm	36.0	sft	0.0
SECOND FLOOR						
13	Bedroom 1	0.0	sm	0.0	sft	0.0
14	Bedroom 2	0.0	sm	0.0	sft	0.0
15	Washroom	0.0	sm	0.0	sft	0.0
Total Net Program Area		73.4	sm	790	sft	84.5
TOTAL GROSS AREA		86.2	sm	949	sft	94.0

3 BEDROOM UNITS			TYPE 1		TYPE 2	
No.	Space Designation	Area (sm)	Area (sm)	Area (sft)	Area (sm)	Area (sft)
1	Heated Crawl Space*	0.0	sm	0.0	sft	
GROUND FLOOR						
2	Entry Porch	4.6	sm	49.0	sft	2.2
3	Entry Hall	0.0	sm	0.0	sft	0.0
4	Living Room	19.5	sm	210.0	sft	23.4
5	Kitchen	11.3	sm	122.0	sft	6.2
6	Washroom	5.1	sm	55.0	sft	4.0
7	Bedroom 1	10.7	sm	115.0	sft	11.1
8	Bedroom 2	8.5	sm	91.0	sft	7.9
9	Bedroom 3	8.0	sm	86.0	sft	6.3
10	Mechanical Room	2.5	sm	27.0	sft	4.8
11	Laundry	5.1	sm	55.0	sft	4.4
12	Cold Porch	5.9	sm	63.0	sft	5.2
13	Storage	2.3	sm	25.0	sft	1.3
14	Hall	5.4	sm	58.0	sft	9.0
SECOND FLOOR						
15	Bedroom 1	0.0	sm	0.0	sft	11.1
16	Bedroom 2	0.0	sm	0.0	sft	10.2
17	Bedroom 3	0.0	sm	0.0	sft	11.4
18	Washroom	0.0	sm	0.0	sft	3.7
18	Hall / Staircase	0.0	sm	0.0	sft	8.0
Total Net Program Area		88.8	sm	956	sft	101.7
TOTAL GROSS AREA		99.9	sm	1075	sft	105.4

4 BEDROOM UNITS			TYPE 1		TYPE 2	
No.	Space Designation	Area (sm)	Area (sm)	Area (sft)	Area (sm)	Area (sft)
1	Heated Crawl Space	0.0	sm	0.0	sft	
GROUND FLOOR						
2	Entry Porch	3.5	sm	38.0	sft	3.5
3	Entry Hall	0.0	sm	0.0	sft	0.0
4	Living Room	14.0	sm	151.0	sft	13.5
5	Kitchen	14.3	sm	154.0	sft	13.5
6	Washroom	3.6	sm	39.0	sft	3.4
7	Mechanical Room	6.2	sm	67.0	sft	5.8
8	Laundry	0.0	sm	0.0	sft	6.7
9	Cold Porch	8.8	sm	95.0	sft	8.8
10	Storage	0.0	sm	0.0	sft	0.0
11	Hall	6.8	sm	73.0	sft	0.0
SECOND FLOOR						
12	Bedroom 1	12.2	sm	131.0	sft	10.6
13	Bedroom 2	9.1	sm	98.0	sft	8.2
14	Bedroom 3	8.9	sm	96.0	sft	8.6
15	Bedroom 4	7.4	sm	80.0	sft	9.1
16	Hall / Staircase	11.8	sm	127.0	sft	9.5
Total Net Program Area		106.7	sm	1149	sft	101.2
TOTAL GROSS AREA		131.6	sm	1416	sft	131.6

3 BEDROOM UNITS			TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5		TYPE 6		TYPE 7	
No.	Space Designation	Area (sm)	Area (sm)	Area (sft)												
1	Heated Crawl Space*	0.0	sm	0.0	sft	0.0										
GROUND FLOOR																
2	Entry Porch	4.6	sm	49.0	sft	2.2	sm	24.0	sft	2.2	sm	24.0	sft	0.0	sm	0.0
3	Entry Hall	0.0	sm	0.0	sft	0.0	sm	0.0	sft	0.0	sm	0.0	sft	4.1	sm	44.0
4	Living Room	19.5	sm	210.0	sft	23.4	sm	252.0	sft	23.4	sm	252.0	sft	26.7	sm	287.0
5	Kitchen	11.3	sm	122.0	sft	6.2	sm	67.0	sft	8.7	sm	94.0	sft	7.0	sm	75.0
6	Washroom	5.1	sm	55.0	sft	4.0	sm	43.0	sft	0.0	sm	0.0	sft	3.8	sm	41.0
7	Bedroom 1	10.7	sm	115.0	sft	11.1	sm	120.0	sft	0.0	sm	0.0	sft	13.5	sm	145.0
8	Bedroom 2	8.5	sm	91.0	sft	7.9	sm	85.0	sft	0.0	sm	0.0	sft	12.0	sm	129.0
9	Bedroom 3	8.0	sm	86.0	sft	6.3	sm	68.0	sft	0.0	sm	0.0	sft	9.0	sm	97.0
10	Mechanical Room	2.5	sm	27.0	sft	4.8	sm	52.0	sft	6.3	sm	68.0	sft	6.1	sm	66.0
11	Laundry	5.1	sm	55.0	sft	4.4	sm	47.0	sft	0.0	sm	0.0	sft	9.6	sm	103.0
12	Cold Porch	5.9	sm	63.0	sft	5.2	sm	56.0	sft	6.3	sm	68.0	sft	6.7	sm	72.0
13	Storage	2.3	sm	25.0	sft	1.3	sm	14.0	sft	0.0	sm	0.0	sft	0.0	sm	0.0
14	Hall	5.4	sm	58.0	sft	9.8	sm	105.0	sft	7.8	sm	84.0	sft	4.6	sm	49.0
SECOND FLOOR																
15	Bedroom 1	0.0	sm	0.0	sft	11.1	sm	120.0	sft	11.8	sm	127.0	sft	0.0	sm	0.0
16	Bedroom 2	0.0	sm	0.0	sft	10.2	sm	110.0	sft	10.9	sm	117.0	sft	0.0	sm	0.0
17	Bedroom 3	0.0	sm	0.0	sft	11.4	sm	123.0	sft	8.1	sm	87.0	sft	0.0	sm	0.0
18	Washroom	0.0	sm	0.0	sft	0.0	sm	0.0	sft	3.7	sm	40.0	sft	0.0	sm	0.0
18	Hall / Staircase	0.0	sm	0.0	sft	8.0	sm	86.0	sft	8.5	sm	91.0	sft	0.0	sm	0.0
Total Net Program Area		88.8	sm	956	sft	87.8	sm	945	sft	101.7	sm	1095	sft	101.7	sm	1095
TOTAL GROSS AREA		99.9	sm	1075	sft	139.2	sm	1498	sft	139.2	sm	1498	sft	111.9	sm	1204

4 BEDROOM UNITS			TYPE 1		TYPE 2		TYPE 3		TYPE 4		TYPE 5		TYPE 6		TYPE 7	
No.	Space Designation	Area (sm)	Area (sm)	Area (sft)												
1	Heated Crawl Space	0.0	sm	0.0	sft	0.0	sm	0.0								
GROUND FLOOR																
2	Entry Porch	4.6	sm	49.0	sft	2.2	sm	24.0	sft	2.2	sm	24.0	sft	0.0	sm	0.0
3	Entry Hall	0.0	sm	0.0	sft	0.0	sm	0.0	sft	0.0	sm	0.0	sft	4.1	sm	44.0
4	Living Room	19.5	sm	210.0	sft	23.4	sm	252.0	sft	23.4	sm	252.0	sft	26.7	sm	287.0
5	Kitchen	11.3	sm	122.0	sft	6.2	sm	67.0	sft	8.7	sm	94.0	sft	7.0	sm	75.0
6	Washroom	5.1	sm	55.0	sft	4.0	sm	43.0	sft	0.0	sm	0.0	sft	3.8	sm	41.0
7	Bedroom 1	10.7	sm	115.0	sft	11.1	sm	120.0	sft	0.0	sm	0.0	sft	13.5	sm	145.0
8	Bedroom 2	8.5	sm	91.0	sft	7.9	sm	85.0	sft	0.0	sm	0.0	sft	12.0	sm	129.0
9	Bedroom 3	8.0	sm	86.0	sft	6.3	sm	68.0	sft	0.0	sm	0.0	sft	9.0	sm	97.0
10	Mechanical Room	2.5	sm	27.0	sft	4.8	sm	52.0	sft	6.3	sm	68.0	sft	6.1	sm	66.0
11	Laundry	5.1	sm	55.0	sft	4.4	sm	47.0	sft	0.0	sm	0.0	sft	9.6	sm	103.0
12	Cold Porch	5.9	sm	63.0	sft	5.2	sm	56.0	sft	6.3	sm	68.0	sft	6.7	sm	72.0
13	Storage	2.3	sm	25.0	sft	1.3	sm	14.0	sft	0.0	sm	0.0	sft	0.0	sm	0.0
14	Hall	5.4	sm	58.0	sft	9.8	sm	105.0	sft	7.8	sm	84.0	sft	4.6	sm	49.0
SECOND FLOOR																
15	Bedroom 1	0.0	sm	0.0	sft	11.1	sm	120.0	sft	11.8	sm	127.0	sft	0.0	sm	0.0
16	Bedroom 2	0.0	sm	0.0	sft	10.2	sm	110.0	sft	10.9	sm	117.0	sft	0.0	sm	0.0
17	Bedroom 3	0.0	sm	0.0	sft	11.4	sm	123.0	sft	8.1	sm	87.0	sft	0.0	sm	0.0
18	Washroom	0.0	sm	0.0	sft	0.0	sm	0.0	sft	3.7	sm	40.0	sft	0.0	sm	0.0
18	Hall / Staircase	0.0	sm	0.0	sft	8.0	sm	86.0	sft	8.5	sm	91.0	sft	0.0	sm	0.0
Total Net Program Area		88.8	sm	956	sft											



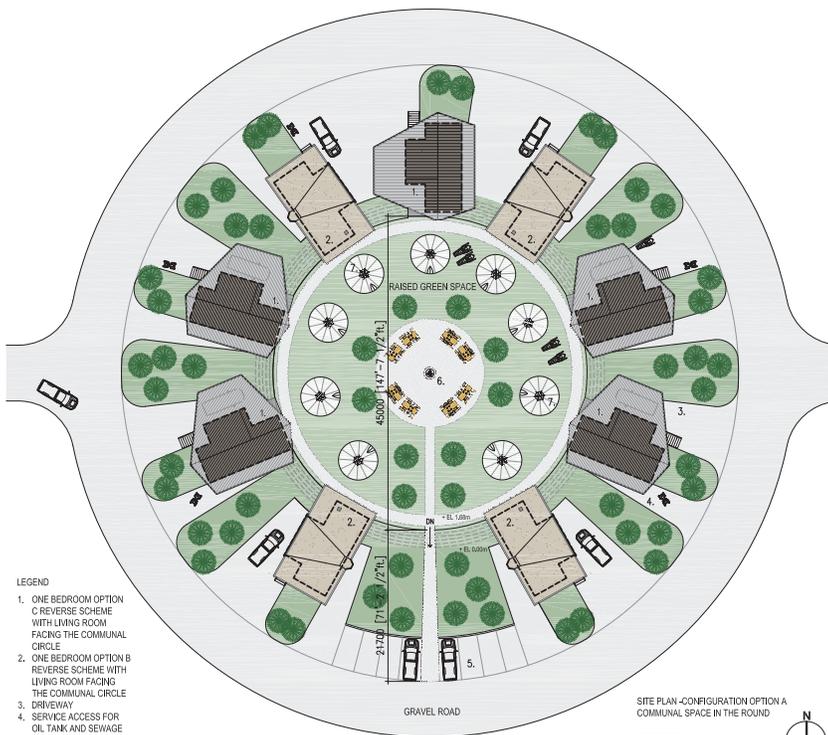
5.13 PROPOSED ALTERNATIVE NEIGHBORHOOD LAYOUT



Optional layouts address the abundant use of sheds, cooking tips, ATVs and snowmobiles by zoning outdoor activities separate from roadways, offering a safe and communal space for these land-based activities. These layouts take in mind the communities current plans to build 10 units on a deserted runway.

The circular layout seen below takes it's form from the communities world views, inspired by the medicine wheel and taking into account the cardinal directions.

Figure 105 Layout option one creates a separate community space removed from traffic with designated Quad/ snowmobile/walking path



- LEGEND
1. ONE BEDROOM OPTION C REVERSE SCHEME WITH LIVING ROOM FACING THE COMMUNAL CIRCLE
 2. ONE BEDROOM OPTION B REVERSE SCHEME WITH LIVING ROOM FACING THE COMMUNAL CIRCLE
 3. DRIVEWAY
 4. SERVICE ACCESS FOR OIL TANK AND SEWAGE PUMP OUT
 5. VISITOR PARKING
 6. COMMUNAL FIRE PIT
 7. COOKING TIPS OWNED BY EACH HOUSE

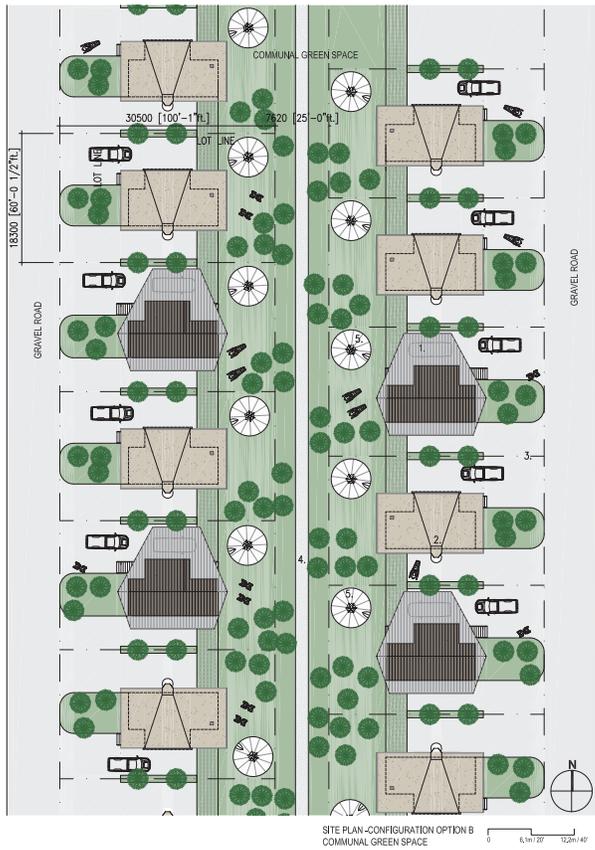


PERSPECTIVE VIEW OF SITE



SECTION THROUGH SITE

Figure 106 Layout option two creates a separate circular community space removed from traffic



- LEGEND BEDROOM OPTION C
REVERSE SCHEME WITH
LIVING ROOM FACING
THE COMMUNAL GREEN
SPACE
2. ONE BEDROOM OPTION B
REVERSE SCHEME WITH
LIVING ROOM FACING
THE COMMUNAL GREEN
SPACE
3. DRIVEWAY / SERVICE
4. TRAIL
5. COOKING TIPS OWNED
BY EACH HOUSE



Figure 107 Community Layout option 1



Figure 108 Community Render



APPENDIX

2 Bedroom Duplex



Figure 109 Duplex with multi-point foundation front view

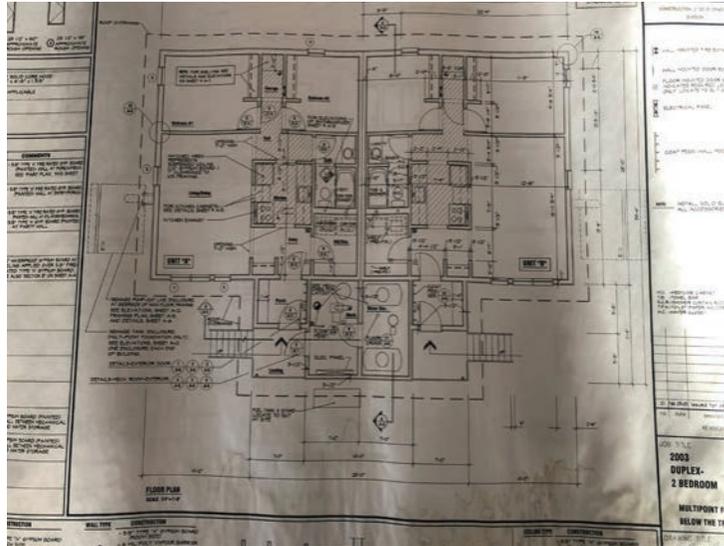


Figure 112 Plan



Figure 110 Duplex with screw-jack foundation front view

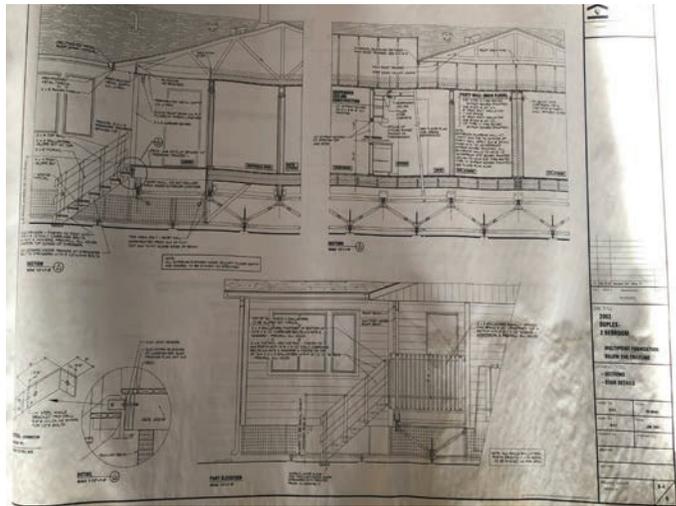


Figure 113 Sections/Elevations



Figure 111 Duplex with screw-jack foundation side view

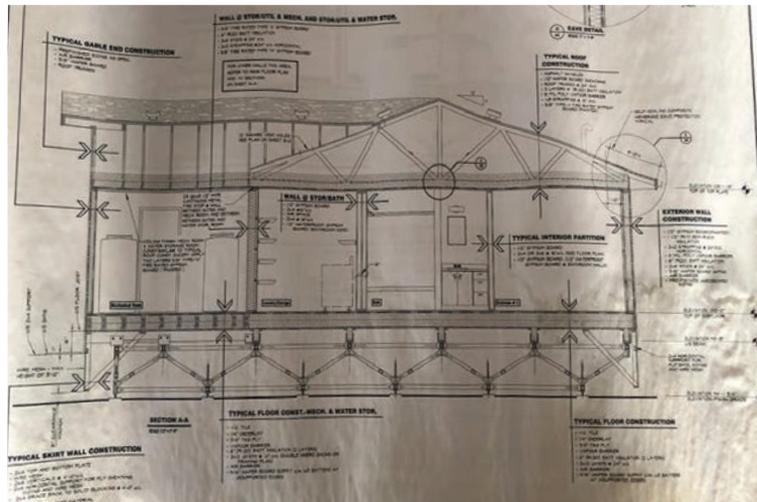


Figure 114 Detailed Section



4 Bedroom House Type Hap G



Figure 115 View of house from lake



Figure 116 Storage in Kitchen



Figure 117 Wood Stove in Kitchen (right)



Figure 118 Entrance Deck to Vestibule

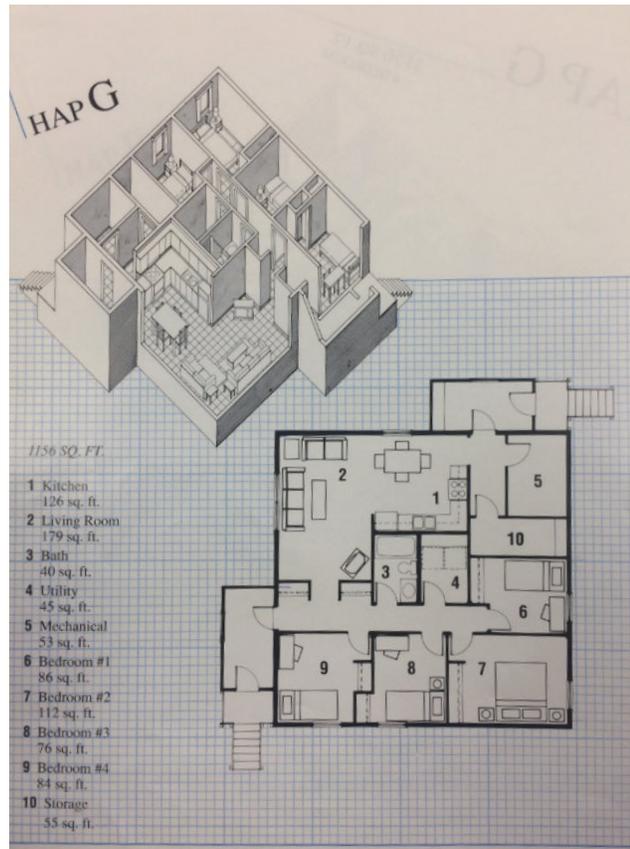


Figure 119 Hap Booklet, Plan and Axonometric

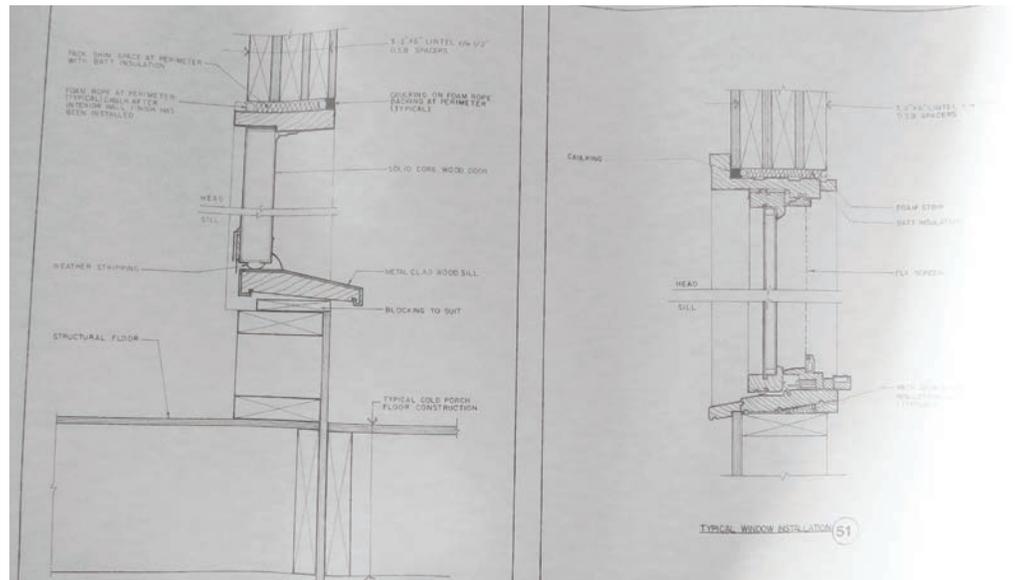


Figure 120 Hap Manual, Standard HAP Window Detail

2 Bedroom House



Figure 121 Front deck with bench and chest freezer



Figure 124 Kitchen



Figure 122 Elevated bathtub and toilet



Figure 123 Additional



Figure 125 Original Vestibule/porch



3 Bedroom House



Figure 126 Wood stove

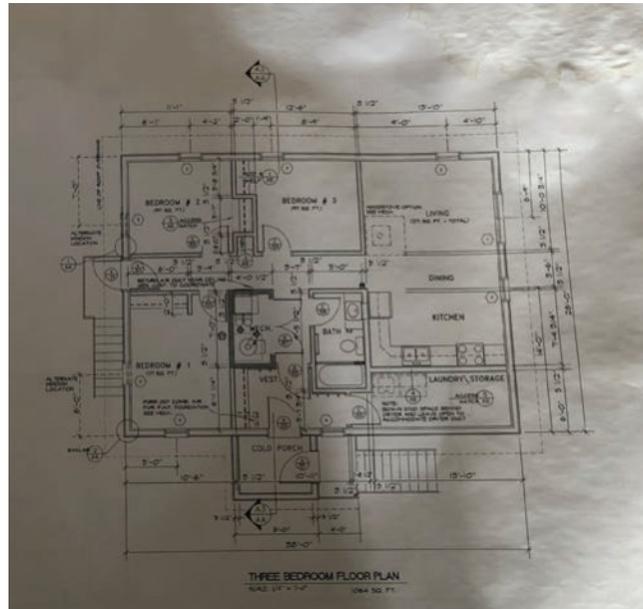


Figure 130 House Front View



Figure 127 Duct outlet

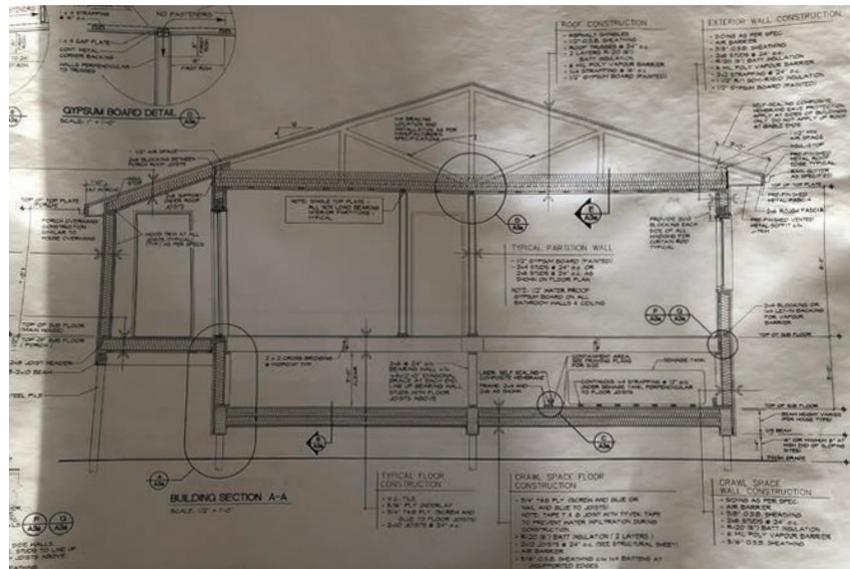


Figure 131 House Front View



Figure 128 Water or Sewage tank in crawlspace



Figure 129 House Front View

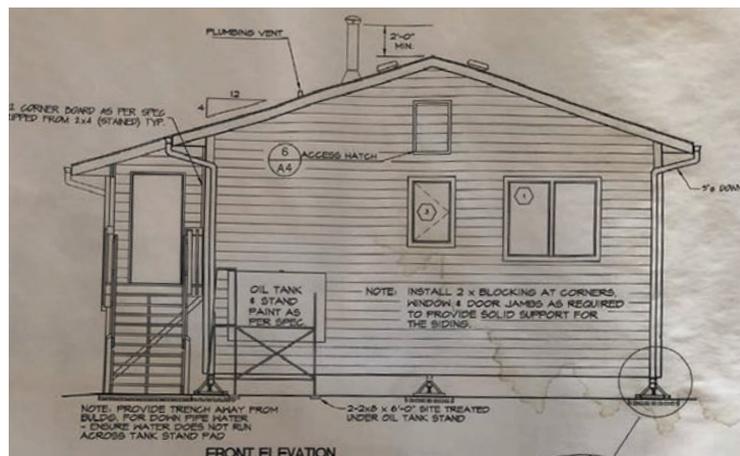


Figure 132 House Front View

Endnotes

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Figure 4: Northwest Territories, Ecosystem Classification Group, Northwest Territories, and Department of Environment and Natural Resources. Ecological Regions of the Northwest Territories, Taiga Plains. Yellowknife: Dept. of Environment and Natural Resources, Govt. of the Northwest Territories, 2009. 147

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